

From the DEPARTMENT OF DENTAL MEDICINE
Karolinska Institutet, Huddinge, Sweden

**OROFACIAL PAIN AND JAW FUNCTION IN
CHILDREN AND ADOLESCENTS: EPIDEMIOLOGY,
BIOPSYCHOSOCIAL IMPLICATIONS AND
CAREGIVERS' APPROACH**

Amal Ahmad M. Al-Khotani
BDS, MSc, Pediatric Dentist



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ADOLESCENTS: EPIDEMIOLOGY, BIOPSYCHOSOCIAL
IMPLICATIONS AND CAREGIVERS' APPROACH**

THESIS FOR DOCTORAL DEGREE (Ph.D.)

Amal Ahmad M. Al-Khotani

Principal Supervisor:

Nikolaos Christidis
Karolinska Institutet
Department of Dental Medicine

Opponent:

Ambra Michelotti
University of Naples Federico II
Department of Department of Neuroscience,
Reproductive Sciences and Dentistry

Co-supervisor(s):

Malin Ernberg
Karolinska Institutet
Department of Dental Medicine

Examination Board:

Göran Isacson
Centrallasarettet i Västerås
Department of Clinical Oral Physiology

Britt Hedenberg-Magnusson
Karolinska Institutet
Department of Dental Medicine

Gunilla Klingberg
Malmö University
Faculty of Odontology

Aron Naimi-Akbar
Karolinska Institutet
Department of Dental Medicine

Göran Dahllöf
Karolinska Institutet
Department of Dental Medicine

Emad Albadawi
Ministry of Health
Jeddah Dental Specialty Center

Mentor

Monica Barr Agholme
Karolinska Institutet
Department of Dental Medicine

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

نَرْفَعُ دَرَجَاتٍ مَّنْ نَّشَاءُ وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ

In the name of Allah, the Most Gracious, the Most Merciful

We raise the degrees of whomsoever We please, and
above every one possessed of knowledge is the
All-knowing one

Surah 12. Yusuf, Verse 76

Dedication

Praise be to Allah Almighty and the exalted Majestic, and prayers to all his servants, messengers and prophets; from the Prophet Adam to the Prophet Mohammad, peace be upon them all.

As a child I grew up with loving, caring, and tender parents, both of whom were successful teachers who encouraged me to reach for success. With neither the support of Allah, nor the encouragement of my parents, this achievement would still have been only a goal on the horizon; thus, with deep appreciation, **I dedicate this thesis to my beloved parents, Ahmad & Mariam.**

For you who encouraged & helped me all along the path; who inspired & sustained me throughout; who taught me love & affection; and who are the best in my life and about my life, and who *are* my life: **I dedicate this thesis to you, my beloved Sameer, Joudi, Mahdi, and Jana.**

ABSTRACT

Relying on practitioner knowledge of the diagnosis and treatment of orofacial pain (OFP) and temporomandibular disorders (TMD) in children and adolescents tends to be insufficient for effective dental practice. To improve overall performance, it is crucial to discuss topics related to practitioner competency, including professional knowledge and its associated perspectives. In light of the prevalence of OFP/TMD, insufficient knowledge in this area might result in under-treatment of children with these conditions.

This thesis consists of four studies. Studies I and II aimed to examine professional knowledge among Swedish and Saudi Arabian practitioners regarding several aspects of OFP/TMD in children and adolescents. Further, the studies investigated whether there is a need to improve education and practices in this field, especially in Saudi Arabia. Studies III & IV investigated the prevalence of OFP/TMD in the general population of Jeddah in Saudi Arabia by determining the number of children and adolescents with diagnoses of TMD in 2014. Further, III & IV aimed to examine which biopsychosocial perspectives possibly affect the incidence of TMD.

In studies I and II, we sent a questionnaire comprised of four domains on OFP/TMD knowledge to 383 dental and medical practitioners (general practicing and specialists) in Sweden and Saudi Arabia. The questionnaire used an 11-point modified Likert scale (0-10) as the response format and all responses were compared to those of the reference group, Swedish specialists in OFP/TMD. We added 10 questions to the questionnaire that allowed the participants to assess their own knowledge. Studies III & IV included 456 children and adolescents (aged 10–18 years), selected from schools (boys and girls separately) in the five major regions of the city of Jeddah, Saudi Arabia. Both schools and school-classes were randomly selected. The children's examinations followed the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD [Axis I & II]). However, for Axis II of the RDC/TMD, we replaced the Symptom Checklist-90-Revised (SCL-90-R) with the Youth Self Report (YSR). All children and adolescents underwent screening for TMD.

The main findings from Studies I and II indicate limitations in almost all domains of professional knowledge among the dental and medical practitioners in both countries with regard to OFP/TMD. Agreement between the Swedish general practitioners and the reference group, however, was higher than between the Saudi Arabian practitioners and the reference group. Highest agreement occurred between Swedish specialists in oral and maxillofacial surgery and the reference group. On the other hand, there were significant associations in self-assessment of professional knowledge

among almost all Swedish groups in all domains except for Chronic pain and Pain behavior. In the Saudi Arabian group, however, there was only a significant association in the Diagnosis and classification domain. The main finding from Studies III & IV was a prevalence of diagnosed TMD in children and adolescents among the Saudi Arabian general population of 27.2%. The studies also found indications of a significant association between a TMD diagnosis and self-reported OFP and/or headache that occurs once a week or more. The same studies reported that aggressive behaviors, depression, anxiety, stomachache, sleeplessness, feeling tired and dizzy, and eye problems are significantly associated with a painful TMD diagnosis compared to children and adolescents with a non-painful TMD diagnosis.

Taking all these studies together, the thesis concludes that there are gaps in professional knowledge of OFP/TMD among both medical and dental practitioners in Sweden and Saudi Arabia. Nevertheless, both professional knowledge and self-assessment ability seem to be higher among Swedish practitioners than Saudi Arabian. This difference suggests improving and modernizing educational methods in undergraduate and postgraduate studies in Saudi Arabia. It also suggests improving the OFP/TMD curriculum in Sweden, especially regarding Chronic pain and pain behavior. Moreover, the results from the present thesis found indications of a high prevalence of TMD among children and adolescents in Saudi Arabia. The prevalence in Saudi Arabia is also high when compared to counterpart studies in Brazil, Germany, and China using the same methodology. No certain conclusions can be drawn from a single study in one country, despite the high prevalence of TMD found, so future studies in other countries are warranted. Similar to many studies, the current results showed a significant association between painful TMD conditions and biopsychosocial factors when compared to pain-free TMD conditions. These findings indicate a need to improve OFP/TMD education in Saudi Arabia and suggest the need for an accredited OFP/TMD specialty in Saudi Arabia.

LIST OF SCIENTIFIC PAPERS

- I. **Al-Khotani A**, Naimi-Akbar A, Björnsson O, Christidis N, Alstergren P. *Professional knowledge among Swedish and Saudi healthcare practitioners regarding oro-facial pain in children and adolescents*. Journal of Oral Rehabilitation. 2016 Jan;43(1):1-9
- II. **Al-Khotani A**, Björnsson O, Naimi-Akbar A, Christidis N, Alstergren P. *Study on self-assessment regarding knowledge of temporomandibular disorders in children/adolescents by Swedish and Saudi Arabian dentists*. Acta Odontologica Scandinavica. 2015;73(7):522-9
- III. **Al-Khotani A**, Naimi-Akbar A, Albadawi E, Ernberg M, Hedenberg-Magnusson B, Christidis N. *Prevalence of diagnosed TMD among children and adolescents: A cross-sectional epidemiological study in the general population*. Accepted.
- IV. **Al-Khotani A**, Naimi-Akbar A, Gjerset M, Albadawi E, Bello L, Hedenberg-Magnusson B, Christidis N. *The associations between psychosocial aspects and TMD-pain related aspects in children and adolescents*. The Journal of Headache and Pain. 2016, 17:30. DOI: 10.1186/s10194-016-0622-0

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LIST OF ABBREVIATIONS

DDwR	Disc Displacement with Reduction
GCPS	Graded Chronic Pain Scale
GCT	Gate Control Theory
GD	General Dentists
GP	General medical Practitioners
ID	Internal Derangement
JDC	Jaw Disability Checklist
JIA	Juvenile Idiopathic Arthritis
JPFS	Juvenile Primary Fibromyalgia Syndrome
KM	Knowledge Management
OA	Osteoarthrosis
OFP	Orofacial Pain
OMS	Oral and Maxillofacial Surgeons
RDC/TMD	Research Diagnostic Criteria for Temporomandibular Disorders
SCL-90-R	Symptom Checklist-90-Revised
SES	Socioeconomic Status
TMD	Temporomandibular Disorders
TMJ	Temporomandibular Joint
YSR	Youth Self Report

PREFACE

During my previous working experience, and in contrast to my expectations, I faced difficulties in the management of patients suffering from pain and impaired function in the temporomandibular region. I wondered about these difficulties, but I was unable to understand exactly why the pain and functional problems occurred; I lacked the knowledge to deal with such cases, because my undergraduate and postgraduate education comprised only a limited theoretical background in this field. At that time, I referred patients with the presence of pain and/or joint sounds to either an oral and maxillofacial surgeon or a prosthodontist. Later, I found out that there was a, for me, new discipline in dentistry for managing these patients, that is, the specialty of orofacial pain/temporomandibular disorders (OFP/TMD). This knowledge inspired me to learn more about OFP/TMD. In addition, during my Master's thesis (on audiovisual distraction in children), I became extremely interested in research. Taken together, these newly found insights, I felt ready to begin my research endeavor in this area, capturing TMD in children and adolescents.

Since beginning my journey with PhD studies at Karolinska Institutet, I acquired not only broad knowledge in the field, but also many other skills that enabled me to assess, analyze, and also reflect upon different methodologies and findings, either individually or within the research group. Further, being in daily contact with experienced researchers has not only added great value to my PhD studies but also enriched my experience. It also gave me a good opportunity to critically review other researchers' work. Besides the theoretical courses for my doctorate, there was a practical side to the studies, with clinical examinations of more than 500 children and adolescents using a standardized, validated examination protocol for TMD. This, however, provided good training in the examination and diagnosis of TMD. Furthermore, experience working in the laboratory, including cell culturing and cytokine analysis were also part of my doctoral studies, which added much value as well.

Meanwhile, I was fortunate to be able to evaluate my research in a place of competence. This gave me the strength to work hard in order to reach a proficient level. I believe that I now am able to assess my progress and also that I am capable of taking the next step in both my clinical and research work. From the viewpoint of a pediatric dentist, I see a great need to push the field of OFP/TMD forward, especially in children and adolescents. My thesis is not the end of my journey – it is the beginning – because several inquiries have now been raised in my mind about the manifestation and spread of OFP/TMD in children and adolescents, and also possible factors or variables that might influence its occurrence.

INTRODUCTION

Orofacial pain/temporomandibular disorders (OFP/TMD) is a new discipline in dentistry, though its management has been part of the dental profession since its inception in the 19th century. Remarkably, until recently many dental schools have provided only minimal theoretical background (such as training in pathophysiology, TMD, and pain mechanisms) with little or no clinical exposure. Extant studies report that pain in the orofacial region is responsible for more than half of health consultations and 80% of dental appointments among adolescents (1). Reports also indicate that some clinicians refer their patients to other practitioners because they feel incompetent. Indeed, research shows that deficiencies in OFP/TMD knowledge are one of the barriers to appropriate pain management in children and adolescents (2). Given these deficits in care, there is a huge need to step forward in this field. Thus, this thesis will address some of these deficits by providing a narrative understanding of the educational implications of professional knowledge, and also the biopsychosocial implications of OFP/TMD in children and adolescents.

HISTORICAL PERSPECTIVE

Since **ancient times**, the study of pain interested not only physicians but also people from other specialties. History records inquiries about the nature of pain in Greece, India, Egypt, and throughout the Arab world. Some believed that pain was a punishment from God and that prayer was the only treatment. Some manuscripts provided incantations for headache, earache, and musculoskeletal pains. Hippocrates believed pain was due to an imbalance in bodily fluids. Between the 2nd and 6th centuries CE, concern about oral pain in children was limited to teething pain (3, 4).

In the **medieval Islamic era** (661–1300 CE), Muslim scientists, who believed that Allah (God) provides a medication for every disease, used translated Greek books as a basis for their learning and investigations. They studied the anatomy of the human body, and they not only elaborated the causes of intra- and extraoral pain (e.g., caries, jaw locking, arthritis, overloading of the orofacial muscles, and headaches) but also discussed the structure of the nervous system and its association with various parts of the brain and body (5).

The **historical perspective** provides a view of development in the field over time. By the mid-twentieth century, scientists in Sweden began to undertake many studies in the field of pain, including such topics as orofacial pain (OFP) and headache in children. These studies formed the foundation of the upcoming research into OFP.

In the 1950s, stomatognathic physiology started to be taught in Scandinavian countries as an independent topic of training. By the 1970s, epidemiological studies of TMD symptoms had indicated its high prevalence and suggested the need for skilled and knowledgeable specialists in Sweden in this field. Thus in 1993, the Swedish National Board of Health and Welfare approved stomatognathic physiology as a separate specialty, one which this thesis will henceforth refer to as an OFP/TMD specialty (6).

Today the core dental curriculum for both undergraduate and postgraduate students treats OFP/TMD as a separate subject (7). As a result, Sweden has seen important developments in pediatric pain approaches and treatment modalities (8). Further, understanding and knowledge of OFP/TMD continues to grow in Sweden and other developed countries. This is not the case in developing countries where the prevalence of OFP/TMD signs and symptoms is comparable to or even higher than in developed countries. For that reason, OFP/TMD, especially in children and adolescents, needs further research to establish new strategies that are tailored to the needs of developing countries and will allow them to keep abreast of the field so that they can work together with developed countries to improve the well-being of all people.

BACKGROUND

Preparation of healthcare providers for professional practice is an important issue that requires much work. As in many professions, the competent professional should strive to create and maintain a balance between the art and science of the work. Competence in a clinical setting is defined as the use of knowledge, skills, clinical thinking, and values in daily practice for the benefit of the individual (9, 10). This competence requires more than just knowledge; one must know how to think, how to assess, how to judge, and how to apply this knowledge in practice (9, 11).

Practitioners must reach the level of competence to maintain lifelong performance. Performance “is a composite of (clinical) cognitive, psychomotor and affective abilities of the individuals alongside their non-clinical skills like team working, situational awareness, etc.” (12). Accordingly, a competent practitioner does not always meet the standards for strong performance and should strive to fulfill certain standards in order to achieve lifelong proficiency and expertise (12). One study defines a person’s ability to do the routine work as competence, whereas the ability to manage non-routine ill-defined problems is known as performance (13).

Knowledge, which has been shown to be a part of performance, is defined as “a stable entity associated with the representation of facts, procedures, principles and theories in any particular domain” (12). The highest standard of quality requires the

appropriate knowledge and professional skills. This combination can improve a practitioners' performance (14).

Epistemology

Epistemology is a branch of philosophy that studies the theory of knowledge and belief. It is derived from the Greek words episteme (ἐπιστήμη) meaning "knowledge," and logos (λόγος), meaning "study of" (15). Epistemology explores what knowledge is and how people know whether they know something or not. It also provides the justification for knowledge (16). The nature of knowledge did not become a field of its own until 1968, when William Perry proposed the epistemology system. Perry suggested that educators ought to use a system that examines students' knowledge from various perspectives and describes their experiences rather than only viewing information in unqualified terms of "right" and "wrong" (17). In 1981, Kitchener and King studied how epistemological concepts influence thinking and rationale. They claimed that using reflective findings helps to solve ill-defined problems and provides the ability to evaluate actual knowledge (18).

Professional knowledge

Professional knowledge is necessary in any line of work in order not merely to retain knowledge that provides power and stability, but also to perform the work properly and well (19). In this respect, professional knowledge should include the following criteria (20):

1. *Propositional knowledge (knowing-that)* is knowledge acquired from school and college (basic and applied science) and public sources.
2. *Practical knowledge (knowing-how)* is knowledge characterized by acquiring information in concert with a skilled behavioral process such as planning, problem solving, reflection, or assessment.
3. *Personal knowledge* consists of pre-propositional impressions.
4. *Moral knowledge* is acquired from the literature and arts.

Professional knowledge is important for healthcare practitioners (21). One review article stated that practitioners use their professional knowledge to decide on the solutions best suited to address specific problems and that unique cases cannot be treated without the application of professional practice knowledge (22). It is possible to improve professional knowledge by transferring knowledge gained from lectures to the clinical setting and then building upon this knowledge using modern educational methods such as reflection and self-assessment (21). Moreover, professional knowledge and its management enable both undergraduates and

novices to work alongside experts without sacrificing performance in order to solve ill-defined problems that cannot be solved by regular guidelines alone. This is an essential prerequisite to the learning process (20).

Knowledge management

Healthcare workers take on a massive workload after they graduate, and it becomes difficult for them to cope with constant changes in the medical sciences field as new discoveries occur. The knowledge conversion cycle is one way that workers with mutual interests can share their tacit and explicit knowledge.

The notion of knowledge acquisition distinguishes between explicit knowledge (*know about*), such as scientific knowledge, and implicit knowledge (*tacit, know how*), such as embedded knowledge, that cannot be codified. However, explicit knowledge is quickly transferred, while tacit knowledge is difficult, slow, and uncertain in its transference (23). Figure 1 shows the knowledge conversion cycle that should be used in medical practice (24):

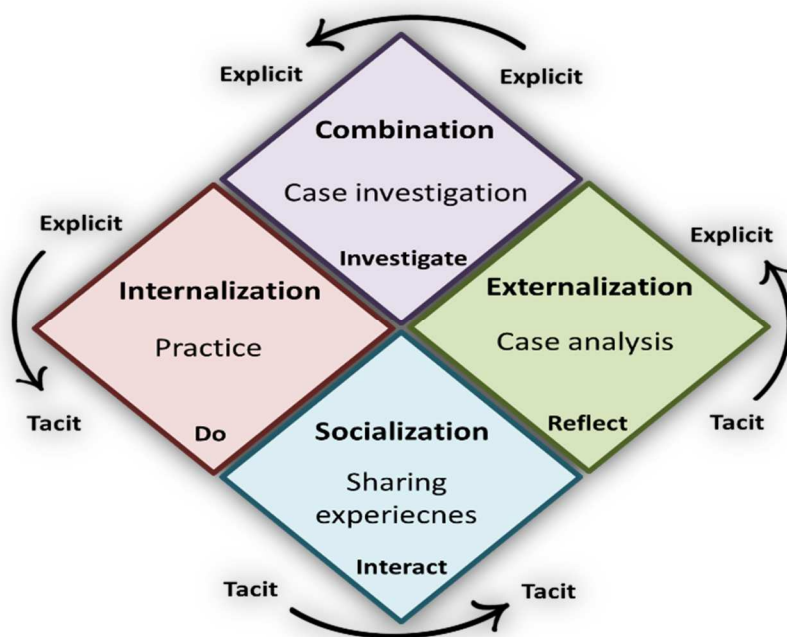


Figure 1: Knowledge conversion cycle (adopted from Montani & Bellazzi, 2002).

- Socialization. Tacit knowledge is effortlessly conveyed between professionals, for example, by recalling and sharing past experiences.
- Externalization. When a person relates their knowledge to others, tacit knowledge becomes explicit, for example, cases analysis and reflection.

- Combination. Previous explicit knowledge adds to new explicit knowledge, for example, case investigation.
- Internalization. Explicit knowledge changes into tacit knowledge that leads to acquiring new skills, for example, experience and practice.

Professional medical education

Education is a combination of attitudes and actions that enables learning to succeed. Learning processes are one part of education in which schemata help to build up knowledge in the mind in a manner that promotes lifelong knowledge (25). The traditional educational model, however, does not prepare the physician well for lifetime medical practice since it is based only on passive transmission of knowledge and experiences, rather than the construction of knowledge by the learner. One study showed that the more a teacher provides the information passively, the less learning takes place (26). Medical curricula, therefore, should enable students to build professional competency through practice-based learning (27). The reason for establishing such learning is to foster the proper capabilities to help learners to manage their own knowledge by using metacognition and/or intuition throughout their professional life (28).

Doctors must be committed to lifelong learning and be responsible for maintaining the medical knowledge and clinical and team skills necessary for the provision of quality care.

— Medical Professionalism Project (2002)

Metacognition and Intuition

Developing **metacognition** is one of the greater challenges in medical education. It is a diverse term that indicates understanding and control of the cognitive processes: it can be defined as self-monitoring and self-management of mental capabilities, such as thinking, in order to make plans before an action; as self-regulation during the action; and then as reflection on the results in order to improve planning of future actions (29). Thus, metacognition has an important impact on learners' success by allowing them to delve deeply into their own learning, which enables them to more accurately judge their own performance or achievements and achieve professionalism (30). Many studies have shown that expert and skilled physicians exhibit higher metacognitive awareness than novice and unskilled physicians (30, 31).

Intuition can be defined as a mental state of using knowledge and experience to rapidly influence both judgment and behavior subconsciously, without actually perceiving it (28). It is a crucial component of expertise and also plays an important role in medical proficiency (28). Intuition can also be called rapid metacognition

because it enables learners to manage clinical cases spontaneously and rapidly by using past experience. Hence, intuition reduces the effort that experts must put into thinking while maintaining efficacy and ability during everyday practice. Expert physicians think metacognitively and act subconsciously using their intuition. In such cases, intuition and metacognition function together throughout the practitioners career, one at the conscious level and the other at the unconscious level (28).

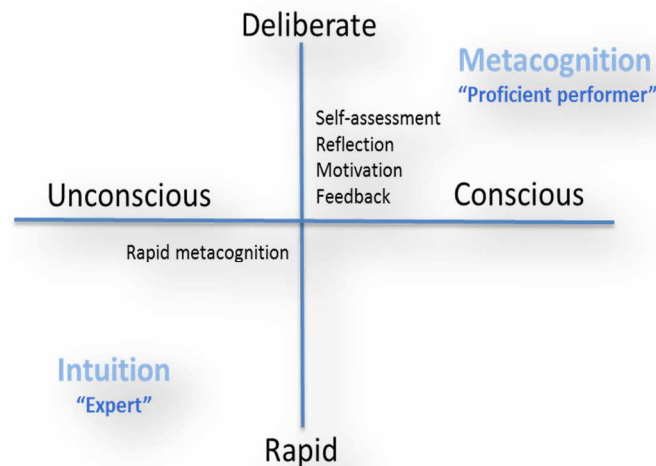


Figure 2: Metacognition and intuition (adopted from Quirk 2006: Intuition and metacognition in medical education: Keys to developing expertise).

Key approaches toward metacognition, intuition, and lifelong learning

As previously suggested, one of the main requirements of any profession is embracing new skills/abilities by applying specialized knowledge throughout a career. This will create self-balance during practice, improving metacognition and intuition in order to reach proficiency. These professional skills and abilities form a basis for subconscious mastery of lifelong learning, which is critical for all healthcare professionals (28, 32). The following section discusses these skills and abilities in greater detail.

Self-assessment and self-directed learning

One goal of education seeks to facilitate learning within a culture of assessment rather than evaluation. The culture of evaluation provides only an overview of performance without actually measuring knowledge acquisition (33). Self-assessment provides an indication of the cognition that someone acquires from the learning process; it is defined as the “learners’ estimate of how much they know or have learned about a particular domain.” (34, 35).

In medical education, continuous self-assessment contributes to positive outcomes, such as skills acquisition, achievement of objectives, follow-up of planning goals,

academic success, greater motivation to learn, and metacognitive progress (28, 36). This self-monitoring process not only benefits novice practitioners, helping them to determine their future training needs, but it also intuitively assists experts to maintain their professional performance (35, 37). Moreover, self-assessment builds self-awareness abilities to expose areas of weakness and limited competence, enabling self-regulation of professional development. One review study reported failure of professionals to accurately judge their own performance and therefore, highlighted the need for self-regulated professionals (32).

Professionals should possess metacognitive abilities to (i) determine whether information about their own knowledge is adequate; (ii) self-assess their own performance; (iii) recognize their own learning needs, (iv) ask for help at the right time, and (v) develop plans to address deficits in knowledge to improve their own learning, achieve academic goals, and maintain lifelong learning (38, 39).

Reflection and feedback

Many studies reported a gap between knowledge and practice called the *theory–practice gap*. However, some studies suggest that this gap arises from a lack of reflection on the actions of daily practice (20, 40). Learning by reflection not only fosters professional development, but also enables practitioners to know the limits of their own knowledge and skills (41). Reflection on one’s own behavior is the main prerequisite to self-assessment and skills development (42). Many studies recommend that undergraduate and postgraduate education include training in self-assessment and reflection to improve retention of knowledge and its application into practice, as well as lifelong learning (39, 43). **Reflection** can be defined as a metacognitive capability that requires deep understanding of both the situation and self-behavior in order to analyze a current accomplishment and consider future actions; it involves learning from an experience before, during, and after the situation (28, 39). Schön (1987) suggested five steps for the reflection process: (a) account, (b) assess, (c) analyze, (d) consider alternatives, and (e) define and act on a plan (44). The Accreditation Council for Graduate Medical Education considers reflective practice to be a basic competency that will improve clinical judgment, develop critical thinking, and help the practitioner to succeed (45).

One important model for reflection in the medical field is the Critical Friends model. Many authors have proposed this model, which provides a new aspect to the reflective process. It is based on a concept of reflective dialogue between the mentor and learner in which the mentor must simultaneously be a critic and a friend of the learner. This mutual conversation will lead to new knowledge, which stimulates the learner’s professional progress and expands professional knowledge (19). In this

respect, education should employ reflection along with tutor-mentor feedback to enhance self-assessment among professionals (43).

Feedback is an informative learning process used in medical education to help promote reflective learning and confirm standards (46). Adult learners appreciate feedback when it addresses their goals, focuses on performance, and provides insight into their actions, allowing them to improve their skills, modify their behaviors, and speed their progress to the next step (47). It is important to employ descriptive, motivating, non-evaluative, stress-free discussion when providing feedback and to agree about differences that arise when they are within the context of discussion (39, 48). Eventually, giving precise and constructive feedback not only strengthens the relationship between learner and mentor, but also builds the learner's trust and analytical skills, improves learning outcomes, and increases critical thinking and competence (47).

Motivation (affection)

Many studies of medical education have concluded that motivation is an essential part of learning; consequently, it can be used as a predictor for academic success and future satisfaction (49). **Motivation** is defined as "the translation of a person's basic psychological needs and drivers, filtered through their view of the world, toward an action with an anticipated result". Motivation can be either intrinsic or extrinsic: intrinsic motivation involves performing an action for the internal sense of reward it provides, while doing things to achieve a desired outcome is called extrinsic motivation (50).

Motivation is one of the important things that an educator does. As such, it is essential for the educator to understand an overview of the coordinated jobs of the brain during emotions and learning. The most important part of the brain is the *neocortex* (Figure 3) where higher order thinking takes place such as thinking, learning, memory, and problem solving. Normally there is ample communication between the neocortex and the other parts of the brain, the *reptilian* and *limbic brains*, which are lower and less involved parts. This communication allows the neocortex to master and control the chemical-electrical impulses to the whole area. When stress or disincentives impair neocortex functions, they trigger downshifting of energy from the neocortex to the reptilian and limbic brains. As a result of this downshifting, energy moves from the higher thinking area (neocortex) toward the lower areas (reptilian and limbic brains). When this happens, the reptilian brain become more dominant and has more control over basic thought processes. With repeated stress and demotivation, thinking will increasingly depend more on the reptilian brain than on the neocortex.

As a consequence of downshifting, learners become less ready to learn, which fosters a lack of creativity and interest in learning (51). Therefore, students' interest will be affected (limbic brain) which, in turn, will affect the entire learning process (52).

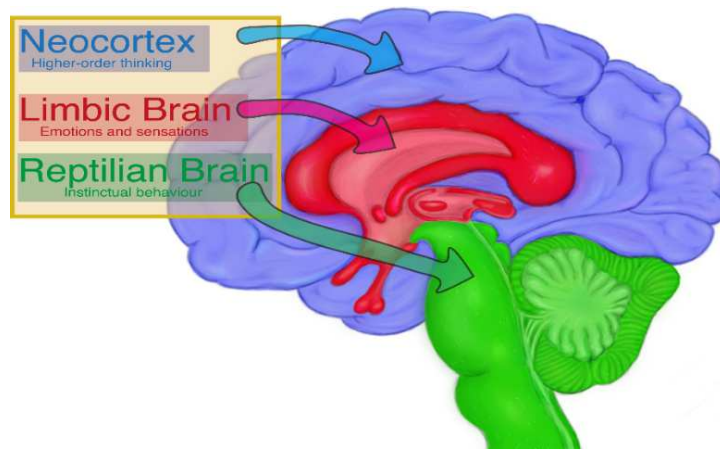


Figure 3: Areas of the brain: the neocortex and the limbic and reptilian brains.

Medicine, as a major, is very well controlled, well organized, and well defined. It is highly influenced by learning outcomes such as performance. A study found that the majority of the medical students selected medicine autonomously based on their internal motivations (53). Motivation increases student's drive to succeed, which, in turn, increases their competence and performance. It also enhances their autonomy, and successively (50).

Professional skills

Professional skills are crucial for the daily practice of healthcare practitioners. **Interpersonal skills** are defined as any skill that involves dealing with others, such as communication, public speaking, or group work (54). On the other hand, **psychomotor skills** can be defined as a personal ability to perform a professional activity, such as the ability to use medical or dental instruments and machines, or computer filing systems (55). In addition to their influence on knowledge, all the factors mentioned earlier (motivation, feedback, reflection, and self-assessment) influence professional skills. Many studies have found that the more the learner's interpersonal and psychomotor skills increase, the more competent they become (54, 55).

"To study medicine without books is like sailing in uncharted sea, but to study medicine from books alone is like never going to sea at all." *Osler, 1897, p. 161*

OROFACIAL PAIN AND TEMPOROMANDIBULAR DISORDERS IN CHILDREN AND ADOLESCENTS

Epidemiology

Epidemiology is the study of a disease or condition in a population with regard to spread, determining factors, and natural history. Studying epidemiology allows clinicians to be familiar with the risk factors, incidence, and prevalence of a condition and provides them with a complete clinical picture to help them reach a definite diagnosis (56). OFP/TMD is a term that describes multiple disorders that affect the oral and facial region which are not merely dental in origin, but are rather due to myogenic, vascular, and/or neuropathic factors; these conditions can drive unnecessary use of medication and overuse of various healthcare services (1). Epidemiological studies of OFP/TMD in children and adolescents are important not only for investigating possible risk factors and associated signs and symptoms, but also for further exploring pathophysiological alterations that accompany craniofacial growth and development in children. For instance, muscle strength normally increases as children grow, which affects the function of associated bony structures (57).

Prevalence and incidence

Prevalence and incidence are epidemiological measures of a disease or condition. Prevalence indicates how widespread a condition is in a population – the proportion of all cases to the population on the whole – over a defined period of time, whereas incidence measures the rate of occurrence of new cases (58). The extensive range of reported chronic pain prevalences is not surprising given the wide variety of differences in methodology and validity of the methods used; sampling approaches; and the cultures, ages, and birthplaces of participants in research studies (59).

Research has shown that TMD is the most common disorder affecting the orofacial region in children, followed by toothache (60). One study found that dental pain and temporomandibular joint (TMJ) pain are less prevalent than headache and abdominal pain among school-aged children (61).

As Table 1 shows, earlier studies have reported prevalences of TMD signs and symptoms ranging from 20% to 33%, and self-reported OFP ranging from 7% to 15%. Only three studies from four countries have reported prevalences of TMD diagnoses in children, adolescents and young adults as determined in a standardized clinical examination. The examinations were conducted according to the Research Diagnostic Criteria for TMD (RDC/TMD); prevalences reached 13%-14%.

Table 1: Studies on the prevalence of orofacial pain/temporomandibular disorders (OFP/TMD).

Author(s)	Country/year	Method	Age	Description	Prevalence
List et al (59)	Sweden 1999	RDC/TMD	12-18 years	TMD pain	7%
Farsi (62)	Saudi Arabia 2003	TMJ Examination	3-15 years	TMD signs & symptoms	20.2% 24.2%
Nilsson et al (63)	Sweden 2005	TMD-Pain [⌘]	12-19 years	TMD pain	4.2%
Feheih (64)	Saudi Arabia 2006	TMJ Examination	12-16 years	TMD-signs & symptoms	21.3% 33%
Casanova- Rosado et al (65)	Mexico 2006	RDC/TMD	14-25 years	TMD diagnoses	46.1%
Pereira et al (66)	Brazil 2009	RDC/TMD	12 years	TMD diagnoses	6%
Moyaho-Bernal et al (67)	Mexico 2010	RDC/TMD	8-12 years	TMD signs & symptoms	33.2%
Hirsch & Wu (68)	Germany 2010	RDC/TMD	13-18 years	TMD diagnoses	13%
Hirsch & Wu (68)	China 2010	RDC/TMD	13-18 years	TMD diagnoses	14.9%
Tecco et al (69)	Italy 2011	RDC/TMD	5-11 yrs 12-15 yrs	TMD symptoms	22.58% 28.2%
Kobayashi et al (70)	Brazil 2014	RDC/TMD	8-14 years	TMD diagnoses	16%
Hongxing et al (71)	China 2015	TMD-Pain [⌘]	12-19 years	TMD pain	14.8%

⌘ Temporomandibular disorder-pain

RDC/TMD = Research Diagnostic Criteria for Temporomandibular Disorders

Age and sex

Age and sex differences in chronic pain among children and adolescents are common in the literature. Chronic pain is showing higher prevalence in children than previously thought, and after puberty, it affects girls more than boys (63, 70, 72-75). On the other hand, a review study has shown that there are no or only slight differences in headache prevalence between boys and girls globally (76). In general, differences in pain between girls and boys may be explained by differences in stress levels, hormonal changes, and pain threshold.

One study reported that the higher prevalence of headache and TMD-pain in girls was significantly associated with social or emotional factors (75). Further, girls reported that pain is aggravated by psychosocial stress, weather, medical illness, and emotions (73).

Pubertal development and hormonal alterations in girls over 10 years of age may be an explanation. Also, a study showed pubertal development to be significantly associated with TMD-pain and depression in girls (77). Another explanation could be that girls frequently use medications and seek social support as soon as they feel pain. Studies have also reported restriction in daily activities for girls before puberty. (73, 78). It is also significant that pain in adolescent girls is more intense, occurs at multiple sites, and appears to be directly associated with pain chronicity and adversely correlated with quality of life (75, 78).

In contrast, studies have shown that boys tend to distract themselves from pain and only report pain when it is triggered by physical activities (61, 77). Males also recover more rapidly from TMD symptoms than females (79).

Concerning age, pain of any type can start early in life and increase gradually with age. Nilsson *et al.* (2009) observed that treatment needs, depressive symptoms, and various somatic complaints increased with age among girls (75). Other studies reported that older children and adolescents seek medical care for their pain more than younger children (63, 73). Furthermore, one important study showed that TMD symptoms start early in childhood and that the prevalence increases in late adulthood when headache and neck pain become more intense (74).

Signs and Symptoms

The following diagram presents the prevalence of common TMD signs and symptoms in children and adolescents as reported in the literature (Figure 4).

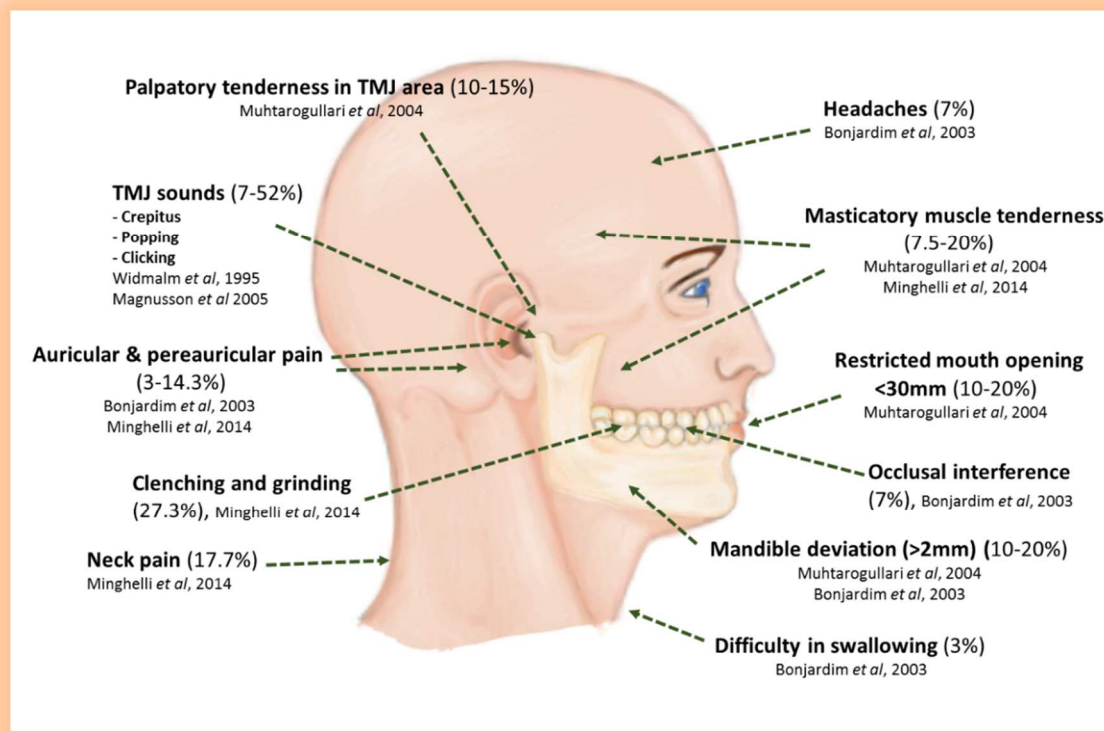


Figure 4: Illustration of TMD signs and symptoms.

Common pain theories for children and adolescents

Pain is a complex phenomenon with sensory, emotional, and cognitive components. The International Associations for the Study of Pain® (IASP®) defined pain in 1994 as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (80).

Many pain theories have been suggested. One that has been well accepted is the Gate Control Theory (GCT, 1965), which describes the central process of pain using a bio-dimensional model (physiology and psychology) (81). Recently, the GCT has evolved by integrating genetic and immunological perspectives to create a biopsychosocial model (1980), that has become well known (82). Understanding this theoretical foundation will elucidate the risk factors and other associations with pain in children, allowing for better pain diagnoses and management.

Biopsychosocial theory and TMD-related factors

The integrated biopsychosocial approach reflects the interconnection between biological, psychological, and social perspectives on pain (83). Its psychological aspect can involve individual beliefs, coping abilities, anxiety and fear, depression, sleep disturbance, and mood changes. Pain’s social aspects include the relationship between

family members and the child, more specific parent-child relationships, culture, socioeconomic status, school environments, and social and peer interactions. Its biological aspects include genetic factors, physical health, pain modulation, hormonal changes, sex, and pubertal development (84).

Biopsychosocial theory can apply to TMD as well. Because the stomatognathic system is unique and TMD tends to occur with comorbid disorders and somatization disorder (psychological distress that the patient experiences as somatic pain), such theorizing should also include functional perspectives. Considerations of functional and mechanical factors should include deep bite, bruxism, malocclusion, parafunction, missing teeth, and facial trauma.

Psychological aspect

Psychological problems such as depression, anxiety, and sleep disturbance are common in children and adolescents (85). It has been suggested that psychological disturbances worsen acute TMD and jeopardize its treatment, thereby predisposing TMD to chronicity (86). Egger *et al.* (1999) concluded that stress, depression, and anxiety were significantly associated with headache, stomachache, and musculoskeletal pain (85). Similarly, List *et al.* (2001) reported that stress – such as school problems, examination, bullying and parental divorce – is a common cause of TMD among adolescents. Stressful situations increase the forces on masseter muscles through clenching and grinding, which sensitize the entire pain pathway. This sensitization arises from the release of pro-inflammatory cytokines and serotonin, leading to TMD, pain, and depression (78, 87).

Other research has shown that increases in urinary catecholamine levels in children with bruxism might be responsible for TMD development (88). A 3-year prospective cohort study examined 11-year-old children who were unsatisfied with life. They found that at age 14, these children developed TMD that meets the RDC/TMD criteria, indicating that this TMD was significantly associated with depression and somatization (89). This has interesting implications when taken together with other reports that showed that adolescents with TMD-pain reported more somatic complaints than adolescents without TMD-pain. The same study showed that somatization presented with depression, anxiety, and general body malfunction in adolescents suffering from TMD (78).

Continuing emotional and anxiety problems can co-occur with TMD into adulthood (90). The notion that pain has no memories to recall may explain this (91). As such, emotional sensations, either pleasant or unpleasant, are a crucial factor in recall of a previous pain sensation as the nociceptive impulses of emotions and stress share a

similar sympathetic nervous system pathways with pain (78, 90). Unlike in adults, where chronic pain leads directly to depression, children with chronic pain primarily report fatigue, low mood, and poor sleep patterns before the depression period (92).

Social aspects

Pain-associated disability, which is the effect of pain on particular aspects of life, is well documented in the literature. Pain-associated disability in children and adolescents can be defined as restriction of daily activities and school attendance due to pain and associated distress (92).

Absence from school is an important concern in many studies of children and adolescents with TMD (78). Headache and arthritis have been shown to cause the highest rate of absence from school (93). One study reported that one out of five children and adolescents went absent from school due to TMD-pain (59). Consequently, children and adolescents suffering from chronic pain experience impairments in their social life and physical activities (94). It is well documented that adolescents with TMD-pain reported limitations in their physical activities and broken social relationships (78). Another study has found that adolescents with headaches reported less time spent with their peers (73).

Sleep disturbance is one domain that correlated with pain in children. Studies have shown that the quality of sleep of those experiencing pain negatively influences school attendance, performance, and social relationships (73). Indeed, children suffering from headache and migraine report sleep disturbances, such as waking at night, nocturnal pain, and daytime sleepiness (95). Similarly, pain among children with juvenile idiopathic arthritis (JIA) strongly affected sleep and caused parasomnias (96).

Furthermore, parents can be undesirably affected by their sick children and suffer from loss of sleep, absence from work, depression, and a breakdown of their social relationships, which can lead to frustration and hopelessness (92). The use of healthcare services is also higher among children and adolescents suffering from chronic pain. This too can have a negative impact on parental anxiety due to the extra time and financial burdens taxing families (60).

Biological aspects

Pubertal growth seems to be a pain predictor for TMD incidence. It has been shown that female sex and the female reproductive hormone are risk factors and pain predictors for TMD (77, 89). Nevertheless, a study among females found that changes (polymorphisms) in the catechol-O-methyl-transferase (COMT) genotype are responsible for TMD-pain onset that meets the RDC/TMD, meaning that when COMT activity decreases, pain sensitivity and risk of emerging TMD increase (97).

Predominantly, pain complaints occurred among parents of children and adolescents with TMD, recurrent headaches, migraine, and/or abdominal pain, indicating that genetic influence might play a role in OFP/TMD in children and adolescents (98, 99).

Functional/mechanical aspect

Studies have emphasized a potent correlation between the presence of one or more parafunctional habits, such as clenching, nail biting, continuous gum chewing, and sleep-related bruxism, and TMD occurrence in children and adolescents (100, 101). One significant longitudinal study followed 378 children for over 20 years and found that tooth wear, deep bite, bruxism, and parafunctional habits during childhood are strong predictors for developing TMD symptoms in adulthood (101). Other studies reported that children who suffered from TMD also complain of clenching or bruxism, difficulty in mouth opening, masticatory muscle tenderness, and TMJ sounds (102).

Morphological facial asymmetry, such as open lips, appears to present in patients suffering from TMD problems (103). It also seems that morphologic malocclusions – such as class III canine relationship, posterior cross bite, anterior open bite, edge to edge (104), and occlusal interference (105) – have significant associations with TMD. Moreover, a 20-year longitudinal study found that unilateral cross bite and Angle Class II are local risk factors for TMD development (102). Another study concluded that 60% of children and adolescents with unilateral posterior cross bite significantly showed TMD symptoms (69). Orthodontic treatment also shows minor correlations with TMD conditions (106).

Recent studies have highlighted the negative effect of posture imbalance and a head-forward posture on head and neck muscles and their associations with TMD among adolescents (107). It has also been shown that trauma, such as extractions, prolonged mouth opening, and sports injuries have a negative effect on the TMJ and might trigger a chronic TMD (108).

Remarkably, playing some musical instruments (such as wind instruments or the violin, which is held between the shoulder and an angled jaw) may apply significant load to the orofacial skeletal system in a way that might cause TMD problems (109). An interesting study showed that playing piano causes three times higher masticatory muscle activity than eating and, consequently, might cause TMD problems. The physical and psychosocial needs of performance (increased levels of concentration, stress, and anxiety) negatively affect the masseter and temporalis muscles, mimicking the clenching process (110).

Classification of orofacial pain in children and adolescents

Based on the origin of pain, orofacial pain can be categorized as Table 2 shows (111):

Table 2: Classification of orofacial pain categorized by origin of pain.	
<i>Odontogenic (tooth-related)</i>	<i>Non-odontogenic</i>
<ul style="list-style-type: none">i. Pulpal Dentinal hypersensitivity Pulp disease (pulpitis)ii. Pathology in periapical region- acute abscessiii. Gum/periodontal diseaseiv. Cracked tooth syndrome	<ul style="list-style-type: none">a. Musculoskeletal conditions (TMD)b. Neuralgias and neuropathiesc. Idiopathic, traumatic, immunologic, infective, erosive, ulcerative, and vesiculobullous and psychosomaticd. Migraine headache, tension-type headache, brain tumor & aneurysms, sinonasal pain, sialadenitis (infection of a salivary gland), and maxillofacial pain caused by cardiac pain referred via the vagus nerve

Temporomandibular disorders

TMD can be defined as a congenital or acquired combination of multiple disorders affecting the TMJ and related musculoskeletal structures in the orofacial area that leads to one or more of the following signs and symptoms:

- Pain on TMJ function in the muscles of mastication and/or pre-auricular area.
- Pain on jaw movement, mandibular deviation and/or limitation of mouth opening.
- TMJ sounds during function, and also other complaints such as headache, earache, and hearing loss.

Adolescence is an adaptive period where the growing sites in the condyle and dentoalveolar region are active and undergo remodeling and growth (112). Once growth ends, the TMJ area and associated structures become stable. However, abnormal tissue breakdown may occur due to inflammation or other causes. In later stages, tissue destruction and loss of condylar structures occur (113). TMD cases can be misdiagnosed and incorrectly treated as a relapse of orthodontic conditions, which can worsen TMD (114). TMD are divided into masticatory muscle disorders and temporomandibular joint disorders.

A. Masticatory muscle disorders

Myofascial pain is chronic musculoskeletal pain that affects the body muscles and fascia (connective tissue) (115). Common risk factors for myofascial pain that occur with arthralgia include trauma, stress, clenching, third molar removal, and female gender (116, 117). Distinguishing features of myofascial pain are dull and recurrent muscle pain that is worse in the morning (due to muscle fatigue from clenching) and that might be accompanied by limitations in jaw movement during chewing with no definite cause (118). In terms of disease progression, adolescents who present with masticatory muscle tenderness and a clenching habit have been shown to be seeking treatment for TMD after 6 years of follow-up visits (119).

Belfer and Kaban (1982) reported that 10% of all myofascial pain conditions occur in children (118). Furthermore, it has been suggested that ill-defined pain in the ear, neck, and shoulder with no definite ear pathology is a significant diagnostic marker for myofascial pain (115). Otalgia is the most common aural symptom reported by patients with TMD, along with other symptoms such as tinnitus, a stuffy sensation, and vertigo. One explanation for the source of the otalgia and tinnitus is referred pain radiating from the masticatory muscles (lateral pterygoid or deep masseter) (120). In general, pain, immobility, and muscle fatigue are common in children, and these act directly on the autonomic nervous system, in turn, activating the sympathetic pathway. Consequently, they can cause tachycardia, chills, sweats, abdominal pain, nausea, and dizziness (92).

B. Temporomandibular joint disorders

Arthralgia can be defined as a non-inflammatory painful joint condition of unspecified cause that affects any joint in the body. It can be iatrogenic or due to arthritis, systemic disease (such as leukemia, histiocytosis, and influenza), infection (such as osteomyelitis), or a tumor (121). Growing pains (also called “benign idiopathic nocturnal limb pains of childhood”) are the most common arthralgia in children, caused by decreases in pain threshold and/or bone strength, and also emotional factors and social stressors. However, growing pains affect mainly the thigh and knee joint and might be associated with joint hypermobility (122). Some studies, though, suggest that growing pains might predict arthritis in children (123). With this indicator and other clinical observations – such as malocclusion, micrognathia, and decreased chewing ability – a dentist might be able to discover arthritis in children early on, which in 70% of cases is asymptomatic (124).

Internal derangement (ID) disorders are mechanical impediments (posterior condylar positioning) that interfere with normal joint movement.

Disc displacement is one form of ID that affects children and adolescents. It is defined as an abnormal relationship between the disc and the condyle and other TMJ components due to trauma, inflammation, or bruxism that leads to functional impairments in the form of clicking and locking ([108](#), [125](#)). Clicking, which co-occurs with disc displacement with reduction (DDwR), consists of abnormal sounds from the TMJ during mandibular movements, whereas locking is an inability to open the mouth co-occurring with disc displacement without reduction. Many studies have suggested various explanations for the incidence of clicking in children and adolescents:

1. Abnormal growth patterns in the TMJ environment, such as reduced forward growth of both mandible and maxilla and decreased downward growth of the mandibular ramus ([126](#)).
2. Long-term tension/activity in the masticatory muscles, which may progress into intracapsular changes, and in turn, TMJ disc displacement ([127](#)).
3. Compression of articular fluid during condylar translation ([128](#)).
4. Joint sounds, which could simply be a sign of normal physiologic transitory growth changes of the TMJ disc contour ([129](#)).

Some studies reported clicking as a predictor of TMD ([101](#)). Many showed difficulties in predicting pathological significance from this sound alone in children; further investigation is needed to confirm a TMD diagnosis ([130](#)). Research reports an increased prevalence of TMJ clicking and signs of peripheral joint disease among patients suffering from hypermobility of the peripheral joint ([131](#)). Noticeably, total anterior facial height and the mandibular plane angle are positively associated with ID, and both are similar to those alterations occurring in JIA cases ([114](#)). ID can be unilateral or bilateral. However, girls have been shown to have a higher prevalence of bilateral disc displacement than boys, while boys have more unilateral disc displacement. This difference may be due in part to female hormonal changes (estrogen), which have a negative effect on collagen synthesis that result in joint laxity. Boys reported unilateral overuse of their TMJ, and they experience trauma to the TMJ more frequently than girls ([132](#)).

Degenerative joint disease (DJD)

- a. TMJ Osteoarthritis (OA) is a chronic joint disease related to various conditions of the articular cartilage that range from normal variations/initial degenerative changes to advanced degenerative changes/cartilage destruction ([133](#)). Changes related to OA can be primary (disc displacement and joint changes) or secondary (arthritis and hypermobility) ([134](#)). Disc displacement and pain

are common signs and symptoms that precede OA and erosion is its most common radiological sign (134, 135). Consequently, altered mandibular growth or function and ID occur in OA (136).

- b. Arthritis is a broad term used to describe pain and stiffness occurring with inflammation (swelling) of the joint. It has two main varieties: rheumatoid arthritis and osteoarthritis. Osteoarthritis is a slowly progressing degenerative joint disease which is uncommon in children but not rare (137). Children's joints are more commonly affected by JIA, which is an asymptomatic autoimmune disease (138). Many significant craniofacial changes involve the TMJ in a growing child; these can include disruptive mandibular growth, such as micrognathia, which affects 30% of children with JIA, and malocclusion, which affects 66% of JIA cases (123, 139). Children with JIA report jaw dysfunction, decreased chewing ability, tooth clenching, headache, shoulder pain, neck pain, and jaw pain, along with impairment of general health (140).

Differential diagnosis of TMD conditions

Many conditions mimic TMD and are often misdiagnosed as TMD. Apart from odontogenic pain, developmental abnormalities, and sinus and otological pain, which are also common in children, juvenile primary fibromyalgia, localized idiopathic pain, neoplasias, parotid diseases, trigeminal neuralgia, vascular diseases, and cervical muscle dysfunction can cause symptoms similar to TMD (1).

Diagnostic procedures for TMD in children and adolescents

A standardized examination for TMD has been used since 1992 when Dworkin *et al.* proposed the RDC/TMD protocol (141). This method of assessment made it possible for researchers and professionals from different specialties and countries to collaborate in large multicenter studies and produce results that could be compared between studies; the strength and reliability of the results were thus increased. Further, the RDC/TMD has been shown to be reliable in children and adolescents as well (142). The RDC/TMD is a diagnostic tool that combines the patient history with a clinical examination. It consists of Axis I, a clinical examination, and Axis II, a biobehavioral questionnaire. In Axis I, the TMJ and orofacial muscles are examined in order to diagnose the presence of one of the following clinical subtypes of TMD: muscle disorders, internal derangement, or degenerative joint disorders. The biobehavioral section is divided into four main domains: the Graded Chronic Pain Scale (GCPS), the Jaw Disability Checklist (JDC), the Depression and Non-specific Physical Symptoms scales, and patient characteristics (141). It has been suggested that healthcare providers routinely screen their patients for TMD-pain in the masticatory

system using two self-report questions proven to be reliable, valid, and highly specific. When done before TMJ examinations, screening makes the self-report of pain among children and adolescents easier. It has also been shown that allowing a short interval of time between screening and the clinical examination increases the accuracy of this measure (143).

Imaging

Imaging is required in specific conditions related to trauma, injury, facial asymmetry, hard tissue crepitus, and cases that don't respond to conservative treatment (60). The most popular radiographic imaging techniques for children and adolescents include the panoramic view, the lateral cephalogram, TMJ tomography, magnetic resonance imaging (MRI), and cone beam computed tomography (CBCT) (144).

Handling TMD in children and adolescents

The purpose of treatment is to remove pain in order to help patients return to their normal lifestyle and activities. It has been suggested that TMD signs and symptoms in children could be resolved and self-limited with no treatment, whereas other studies show that a conservative and simple form of therapy is effective in reducing TMD symptoms in children and adolescents (145, 146). However, a multidisciplinary approach is sometimes needed, especially when TMD-pain involves psychosocial complaints such as depression, anxiety, or school absence.

Patient education is a very important step in TMD management. It includes relaxation training, patient awareness of clenching and grinding habits, and development of behavior coping strategies (147). In one randomized trial, adolescents receiving occlusal appliance therapy along with proper clinical information showed significant improvement on the recorded pain index (148). Besides medication, the following are important to provide TMJ orthopedic stability: splint therapy (e.g., a hard or soft splints), physical therapy (e.g., jaw exercise, iontophoresis, massage, thermotherapy, and coolant therapy), and behavioral therapy (e.g., avoiding too much hard food or gum chewing, avoidance of stressors and decreasing stress, anxiety, and/or depression) and having enough sleep (149).

In summary, few studies in children and adolescents have examined OFP/TMD diagnosis and management; have reported the prevalence of TMD signs and symptoms, either among the general population or in those seeking care who are being screened using the RDC/TMD; or have explored healthcare providers' knowledge and abilities to manage OFP/TMD cases. These studies, however, have found not only deficiencies in knowledge and experience of OFP/TMD, but have also reported that pain treatment in children and adolescents is usually undermanaged.

THESIS AIMS AND HYPOTHESES

The general aims of this thesis were to explore the prevalence of diagnosed TMD in children and adolescents in the general population in Saudi Arabia and to investigate the biopsychosocial factors that could affect its incidence. The research project also evaluated the professional knowledge of Swedish and Saudi Arabian practitioners concerning OFP/TMD in children and adolescents to discover whether there is a need to improve education and practice in this field, in Sweden or Saudi Arabia.

Specific aims

- To explore the professional knowledge regarding OFP/TMD in children and adolescents in Swedish and Saudi Arabian dental and medical specialists.
- To determine the degree of self-assessment of knowledge among dentists in Sweden and Saudi Arabia regarding OFP/TMD in children and adolescents and also the potential factors that might influence self-assessment of knowledge.
- To determine the prevalence of TMD in children and adolescents in the Saudi Arabian general population using the RDC/TMD examination.
- To find possible psychosocial factors that affect the incidence of TMD in children and adolescents in the Saudi Arabian general population.

HYPOTHESES OF THE THESIS

The hypotheses of this project were:

- The prevalence of TMD in children and adolescents is common in Saudi Arabia.
- The majority of children and adolescents with TMD have myofascial pain.
- The prevalence of TMD increases with age and is higher among girls.
- Psychosocial factors, such as depression and anxiety, are associated with TMD.
- Social relations are negatively influenced by TMD-pain among children.
- Somatic factors, such as headache, are correlated with painful TMD conditions.
- Knowledge regarding OFP/TMD is higher among Swedish than among Saudi Arabian practitioners.

MATERIALS AND METHODS

MATERIALS AND METHODS

Studies I & II

Table 3 displays Studies I and II. They were excused from receiving ethics approval since no personal data could be linked to contributors. They used a questionnaire adopted from LeResche *et al.* (150) and Tegelberg *et al.* (151) that is reliable, valid, feasible, and relevant. Selection of participants proceeded as follows:

Table 3: Studies I and II carried out in 2 countries, Sweden and Saudi Arabia.	
Sweden	Saudi Arabia
<p>We sent the questionnaire to each participant's postal address. They received a reminder after 3 weeks and a final reminder after another 3 weeks.</p> <p>The 190 potential participants (Study I) were selected as follows: (Figure 5).</p> <ol style="list-style-type: none"> 1. General dentists working in large (>6 dentists) dental clinics in the private sector or the Public Dental Service in Stockholm 2. Dental specialists (in orofacial pain and jaw function; pediatric dentistry; orthodontics; oral and maxillofacial surgery) working in the Public Dental Service and private sector and on university dental faculties in Stockholm, Gothenburg, Umeå, and Malmö. 3. Pediatric physicians working at university hospitals in Sweden and general medical practitioners from the primary healthcare centers in Stockholm city center. 	<p>We anonymized the questionnaires by numbers before booking an appointment with the participants to distribute the questionnaire and another appointment to collect it back.</p> <p>The 193 potential participants (Study I) were selected from three cities – Jeddah, Makkah, and Riyadh – as follows: (Figure 5).</p> <ol style="list-style-type: none"> 1. General dentists and general medical practitioners from large private (>6 dentists or physicians) or governmental hospitals. 2. Dental specialists (in: pediatric dentistry; orthodontics; oral and maxillofacial surgery) recruited from university dental faculties and from both public and private multidisciplinary clinics. 3. Pediatric physicians working at university hospitals and public hospitals in Saudi Arabia.

Study II included 125 general practicing dentists and specialists (in orofacial pain and jaw function [only Sweden]; pediatric dentistry; orthodontics, oral and maxillofacial surgery) from each country.

A questionnaire was distributed to 383 medical and dental practitioners

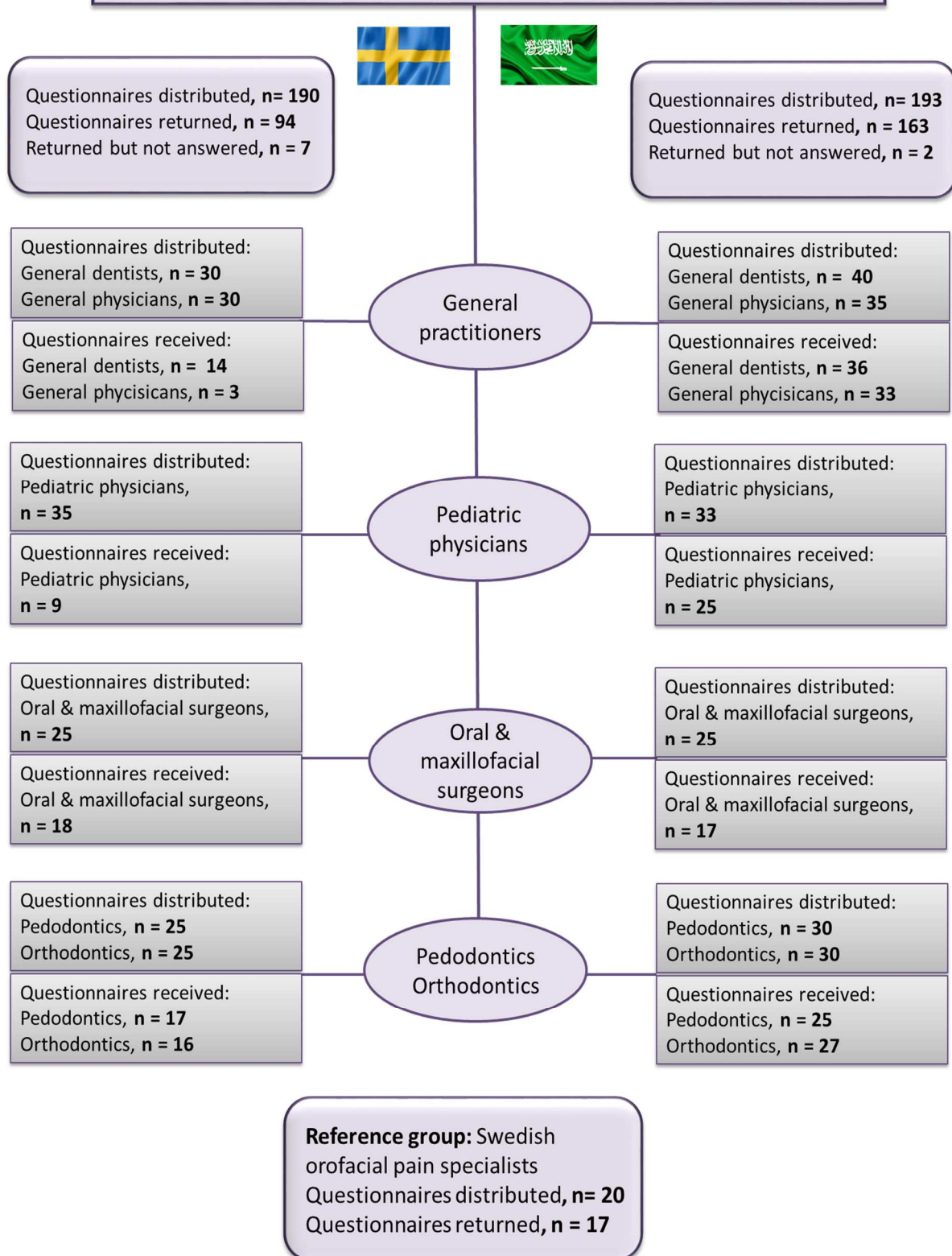


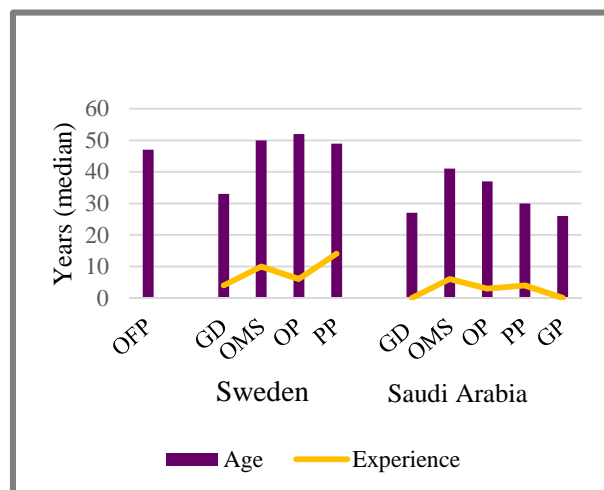
Figure 5: Flowchart presenting the drop-out behavior of 383 participant Swedish and Saudi Arabian practitioners and the reference group.

Table 4: Demographic data for the 383 participants in Studies I & II.

	Participants	Gender M/F	Median age	Percentile	
				25 th	75 th
RG*	Swedish orofacial pain specialists	7/11	47	37	56
Sweden	General dentists	7/8	33	30	45
	Oral and maxillofacial surgeons	12/3	50	46	56
	Orthodontists and pediatric dentistry	11/22	52	40	59
	Pediatric physicians	7/2	49	44	63
Saudi Arabia	General dentists	18/18	27	26	28
	Oral and maxillofacial surgeons	8/5	41	31	54
	Orthodontists and pediatric dentistry	29/22	37	32	43
	Pediatric physicians	8/17	30	27	43
	General medical practitioners	17/16	26	25	28

*RG: Reference group

Figure 6: A diagram shows the median age and median years of experiences among 383 dental practitioners in Sweden and Saudi Arabia, (OFP = orofacial pain specialists; GD = General dentists; OMS = Oral and maxillofacial surgeons; OP = Orthodontists and pediatric dentists; PP = Pediatric physicians; GP = General medical practitioners)



Questionnaire

In **Study I**, the questionnaire comprised four domains with 37 statements:

1. *Chronic pain and pain behavior* (7 statements)
2. *Etiology* (9 statements)
3. *Diagnosis and classification* (11 statements)
4. *Treatment and prognosis* (10 statements)

In addition to the 37 questions, **Study II** included 10 additional relevant and summative questions that apply the basic assessment strategies reported in Manogue *et al.* (2002) (35). Those self-evaluation questions were structured to estimate each participant's knowledge of TMD. They also contained other questions concerning the source of this acquired knowledge, which could be undergraduate, postgraduate, or continuing education, or direct clinical experience.

Each statement used an 11-point modified Likert scale in which 0 represented "completely disagree"; 10, "completely agree"; and 5, "neutral". There was also the option "Don't know/Not applicable".

Pilot revision

Before finalization of the statements and the layout of the questionnaire, we tested a pilot questionnaire on 5 dentists from each country. Revision of the final questionnaire took their comments into consideration.

Studies III & IV

Studies III & IV had a cross-sectional design and took place in the city of Jeddah, Saudi Arabia. The studies received approval from the ethics committee of the Department of Medical Study and Research at the Ministry of Health in Jeddah, Saudi Arabia. All subjects or their parents provided written informed consent. The studies divided Jeddah into five regions (North, South, East, West, and Central) as clustered by the Ministry of Education. According to the power calculation, 450 children and adolescents were necessary to detect true odds ratios (ORs) for disease of 0.538 up to 1.860 with a power of 90% and a significance level of 0.05. The studies randomly selected a total of 633 students from boys' and girls' schools located in each region by using <http://www.randomization.com/>. Of these, 509 students agreed to participate and 456 completed all questionnaires and participated in the clinical examination. The studies involved 20 schools (Figure 7). Additionally, a dental assistant who was not participating in data collection randomly selected one class from each school, with an average of 30 pupils, by drawing the names of the classes from a bucket. The students' ages were between 10 and 18 years.

Due to cultural considerations, the studies invited boys accompanied by their parents to be examined in a dental clinic at the primary healthcare center for each region. Girls were examined in the school nurse's room using a mobile dental chair. The students' parents received envelopes containing a consent form together with a questionnaire collecting general personal information (nationality and socioeconomic background, health status and medical history information) one day before the examination.

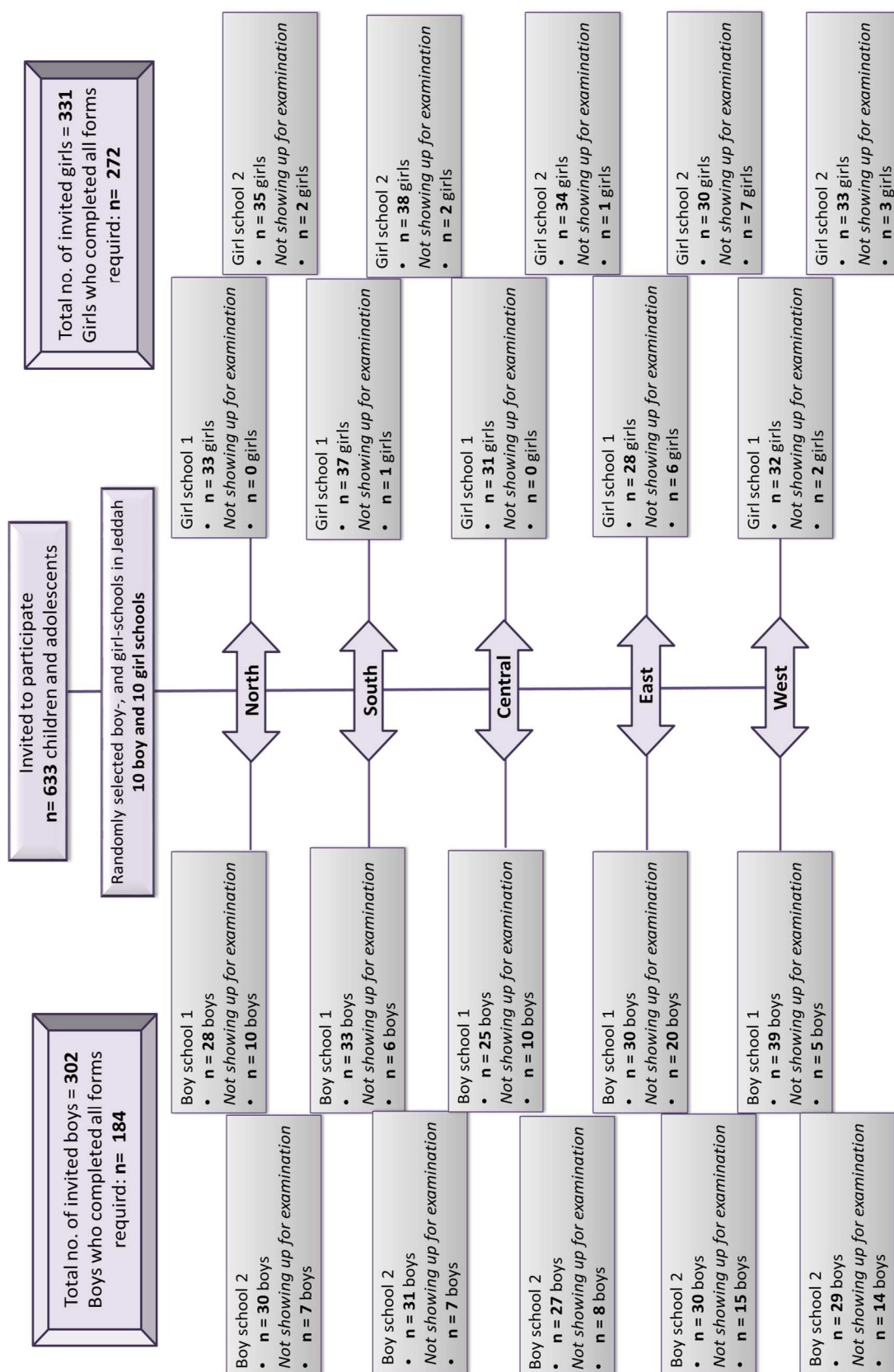


Figure 7: Flow diagram showing the distribution of the children from 20 schools, Jeddah, Saudi Arabia

Table 5: Demographic data of 456 children and adolescents from the general population in Jeddah, Saudi Arabia.		
	Boys n (%)	Girls n (%)
Individuals	184 (40.4%)	272 (59.6%)
Age		
Mean (SD)	14.8 (2.4)	13.5 (2.1)
10–13 years	69 (37.5%)	166 (61%)
14–18 years	115 (62.5%)	106 (39%)
Nationality		
Saudi Arabian	130 (70.7%)	161 (59.2%)
Non-Saudi Arabian*	54 (29.4%)	111 (40.8%)
School-level		
Primary (grade 1-6)	47 (25.5%)	166 (61%)
Intermediate (grade 7-9)	77 (41.9%)	62 (22.8%)
Secondary (grades 10-12)	60 (32.6%)	44 (16.2%)
Parental income		
Below average	78 (44.3%)	155 (58.1%)
Average	63 (35.8%)	86 (32.2%)
Above average	35 (19.9%)	26 (9.7%)
Living with		
Both parents	167 (92.8%)	255 (93.8%)
One parent	13 (7.2%)	17 (6.3%)
* = Middle East, Gulf Region and Africa		

Diagnostic procedure of TMD

After an explanation of the purpose of the study, students answered two validated questions to determine the presence of orofacial pain (**TMD-pain**): (1) “Do you have pain in the temple, face, temporomandibular joint, or jaws once a week or more?” (2) “Do you have pain when you open your mouth wide or chew once a week or more?”. Each student had to answer either “yes” or “no”. Presence of TMD-pain was considered “yes” if the answer to either of the two questions was “yes.” We also asked each student about the presence of headache, day time (clenching & grinding), previous trauma to the face, and history of oral appliances. Each student also received the Youth Self Report (YSR) questionnaire, which we collected at the time of the examination.

Administering the RDC

a. Clinical examination (Axis I)

One examiner (A A-K), trained in this procedure by an orofacial pain specialist (Malin Ernberg and calibrated by a gold-standard examiner (Thomas List), performed the clinical examinations of the TMJ region according to the RDC/TMD (axis I) protocol (141).

b. History questionnaire (Axis II)

(1) GCPS and JDC: These evaluate physical function in the RDC/TMD Axis II. The GCPS severity scale is divided into two parts. The first part assesses characteristic Pain Intensity (PI) and the second part assesses limitations in physical function due to pain, including Disability Days (DD). Disability days comprise four grades (0–3) where 0 = 0–6 DD; 1 = 7–14 DD; 2 = 15–30 DD; and 3 = 31+ DD. Physical functioning disability points (DP 0–6) were combined with pain intensity scores (0–100) to assess physical function as follows:

- i. Grade 0 = no TMD-pain in the previous 6 months.
- ii. Grade I = low disability (<3 DP) and low intensity pain (<50).
- iii. Grade II = low disability (<3 DP) and high intensity pain (>50).
- iv. Grade III = high disability and moderate limitation (3–4 DP regardless of pain intensity).
- v. Grade IV = high disability and, severe limitation (5–6 DP regardless of pain intensity).

The JDC contains 12 yes-or-no questions to assess the extent to which TMD interferes with activities specifically related to mandibular function.

(2) Depression and Non-Specific Physical Symptoms scales: Because the SCL-90-R is not validated for children under 13 years of age (152) , several recent studies on children and adolescents have used the YSR to assess depression and non-specific physical symptoms such as somatic pain (somatization) and comorbid conditions (75, 78). The YSR is a multi-dimensional assessment method widely used in research and clinical settings. It is a reliable and valid standardized diagnostic instrument for measuring self-reported competencies and psychological/somatic problems in children and adolescents with at least a fifth grade reading level and a mental age of at least 10, but who are not older than 18 years of age (153). Some studies, however, suggest that the YSR can be used with children as young as 6 years old with assistance (154). Study IV used the Arabic version of the YSR, licensed

from the ASEBA/Research Center for Children, Youth & Families, University of Vermont, Burlington, VT USA. Due to cultural considerations, we removed three statements from the Arabic version of the YSR.

The YSR consists of two main domains: the Problem Checklist and Social Competence. **The Problem Checklist** domain contains 112 problem statements. The statements illuminate the major clusters: anxiety, depression, somatic complaints, aggressive disorders, and social and attention problems. The major clusters are grouped into three subscales: (a) broad-band internalizing and externalizing, (b) eight narrow-band syndromes, and (c) DSM-oriented scales .

DSM involves the combination of the dimensional and categorical models into a single assessment approach to form DSM-Oriented Scales, which are the product of a rational structure developed by 22 experts in child mental health from 16 different cultures. DSM-Oriented Scales measure psychological disorders in youth such as fear, anxiety and depression, somatic complaints, attention deficit/hyperactivity, and oppositional defiant problems (153).

The Social Competence domain comprises seven statements. The statements cover three areas: social relationships, physical activities, and the mean of self-reported academic performance.

Respondents rate each statement as 0 (not true), 1 (somewhat or sometimes true), or 2 (very true or often true). We used a licensed software scoring program (ASEBA™ version 9.1) for data entry (scores) and proper grouping of the data into subscales. Thus, we present percentiles and T-scores for all subscales and syndromes. The normal T-score range for all syndromes is 50–64; the borderline clinical range, 65–69; and the clinical range, 70–100. The normal T-score range for social competence domains is 36–65; the borderline clinical range, 32–35; and the clinical range, 20–31.

Statistics

Studies I & II

Figure 4 presents participant drop-out in Studies I and II. Participants were divided into two groups depending on their country, the Swedish and Saudi Arabian groups. The reference group was Swedish OFP specialists, whom we considered as a separate group for comparison. Reference group statements reflected consensus if more than 75% of subjects reported either an 'agree' (score 7–10) or a 'disagree' (score 0–3), according to the definitions of LeResche *et al.* (1993) (150).

With regard to participant groups, we analyzed the level of knowledge among the participants when the answers agreed with the reference group. Descriptive statistics included the number of subjects and frequencies of variables. We analyzed score differences between subgroups in Study I using logistic quantile regression. For statements where Swedish TMD specialists showed agreement (either agree or disagree on a statement), we analyzed the 25th and the 75th percentile, considering an answer to be correct when it was within the 25th and 75th percentile of the reference group. P-values were based on 100 bootstrap samples with a probability level lower than 0.05 considered significant.

Study II used quantile regression to analyze whether the dentists' own self-assessment of their knowledge predicted the median number of correct answers. The study included a statement about the dentist's self-assessed knowledge (Range = 0–10, where 0 equals insufficient knowledge and 10, sufficient knowledge) modeled as a continuous variable with a separate analyses for each of four different statements about knowledge. These analyses were stratified by country.

Studies III & IV

In Study III, data analysis began by the scoring the TMD diagnosis using Axis I Diagnostic Algorithms. We divided these into three groups: Group I, Muscle disorders (Myofascial pain with and without limited mouth opening); Group II, Joint disorders (Disc displacement with and without reduction); and Group III, inflammatory-degenerative disorders (Arthralgia, Osteoarthritis and Osteoarthritis).

Depending on the diagnoses found in Study III, we divided the 456 participants into three other groups in Study IV: no TMD, TMD with pain, and pain-free TMD. Univariate analyses of associations between TMD diagnoses and potential predictors in Studies III & IV used the chi-square test. To analyze potential predictors of the various TMD diagnoses, a multivariate logistic regression model calculated ORs. Statistical analyses used STATA 12 SE, considering a 95% CI not including 1 and *p*-values less than 0.05 as statistically significant.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Prevalence of TMD diagnoses

The current study demonstrated that 124 of 456 of Saudi Arabian children and adolescents had at least one type of TMD. Figure 8 shows that myofascial pain is the most common TMD diagnosis in children, followed by DDwR, and arthralgia. A review study found DDwR (8.9%-15.8%) to be the most prevalent diagnosis in the adult general population, followed by myofascial pain (6%-12.9%), and arthralgia. The same review found that arthritis is uncommon in the adult general population and this agrees with our results, which found only one case of osteoarthritis (155).

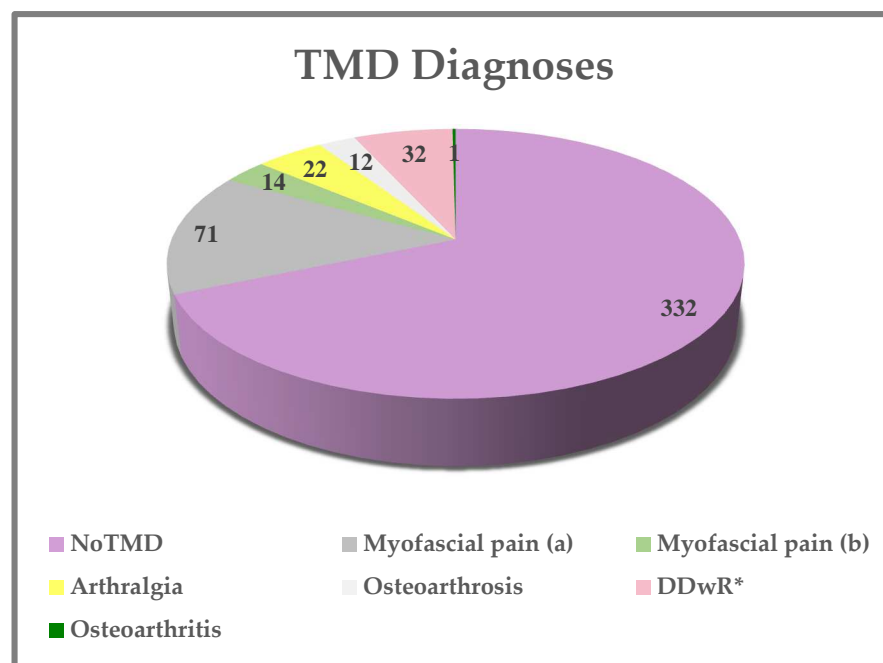


Figure 8: A diagram illustrating various TMD diagnoses among 456 students in the general population.

(a) = without limited mouth opening, (b) = with limited mouth opening.

* DDwR = Disc Displacement with Reduction

An unexpected finding was no significant differences concerning sex or age regarding diagnoses, except for the myofascial pain with limited mouth opening where all children and adolescents in the group were girls. This higher frequency of myofascial pain in girls was also reported in a recent study (69).

The older age group, however, showed a slight increase in the prevalence of TMD diagnoses compared to the younger age group. These findings are in contrast with other studies in Sweden and China showing that self-reported TMD-pain occurring

once a week or more is significantly correlated with increases in TMD prevalence both with age and among girls (63, 71). In contrast to previous research from that has shown that boys are more physically active than girls in Saudi Arabia (156), the boys in this thesis (Study IV) had the same level of physical activity as the girls; both boys and girls were within the borderline clinical range for physical activity in the Social Competence scales of YSR. This could be because many boys suffered from TMD-pain and recent research indicates that pain affects physical activity (94). However, the opposite interpretation of this correlation might be correct (157): the present study found no sex differences because the male subjects had a lower degree of physical activity than normal. Another possible reason for this difference could be related to the higher drop-out rate of boys than girls in our study, which could indicate a sampling bias.

Table 6 presents the combined TMD diagnoses. Of the studied students, 5.3% reported a combination of two diagnoses and only two students reported a combination of three diagnoses. To the author's knowledge, no previous study has presented data on multiple diagnoses in children and adolescents in a general population. Many studies have presented the prevalence of multiple diagnoses in an adult patient population, reporting rates of 14% for the combination of two diagnoses and 11% for three diagnoses (158).

Table 6: Number of children with combined TMD diagnoses among the 456 examined children in the general population of Jeddah, Saudi Arabia.			
TMD Diagnoses	Myofascial pain	Arthralgia	Osteoarthritis
Arthralgia	9		
Osteoarthritis	2	1	
DDwR	12	5	1
DDwR = Disc Displacement with Reduction			

Self-reported variables and physical functioning

In contrast to the No TMD group, self-reported headache, orofacial pain, and clenching all showed significant associations with TMD (Study III). Within the TMD group, 71.8% indicated self-reported orofacial pain occurring once a week or more and 39.8%, headache.

Table 7 shows various TMD diagnoses with their significant associations to self-reported variables. Similar to the findings from Study III, earlier studies have shown that TMD incidence is significantly associated with headache in children and adolescents (159, 160). One longitudinal study also showed that headache is associated with TMD occurrence (105).

Table 7: Significant correlations between temporomandibular disorders (TMD) diagnoses and self-reported variables.					
	Pain*	Headache	Clenching	Grinding	Allergy
Myofascial pain	√		√		
Arthralgia	√			√	√
DDwR		√		√	
TMD total	√	√	√		
√ significant association, $p < 0.05$ * TMD-pain occurring once a week or more. DDwR = Disc Displacement with Reduction.					

With respect to parafunctions, a study in Saudi Arabia showed that clenching and grinding correlate with TMD signs and symptoms in children, which is similar to the Study III findings shown in Table 7 (161). Furthermore, pain and muscle tenderness have been reported in adolescents diagnosed with TMD (65). Earlier reports indicate that, in adults, myofascial pain with or without arthralgia correlates with clenching and grinding; both results are in agreement with Study III (117).

Furthermore, Study III found allergies to be a background factor statistically associated with arthralgia. Many previous studies have shown that children with JIA suffering from TMD often present with allergies (162). Interestingly, other research has shown that grinding and allergies are correlated with arthralgia in children (163, 164), results similar to the findings of Study III.

In contrast to adults (165), the majority of children and adolescents in the current study reported little to no pain disability, and only 6% reported high disability and pain intensity. Furthermore, the GCPS showed significantly higher scores among the

TMD groups, especially the myofascial pain group. The jaw disability checklist indicated significant limitations related to “having a usual facial appearance” in most of the TMD diagnoses in addition to other limitations, as Table 8 shows.

A finding of particular interest in Study III is that more than three-quarters of diagnosed children and adolescents had never visited a physician or dentist for their pain. This agrees with a Swedish study that reported that about more than half of children and adolescents with TMD needed treatment for their pain (63). Recently, one study among adolescents showed that about half of the TMD-pain group reported treatment needs (71). List *et al.* found comparable findings, with about 51% of those reporting TMD-pain having perceived treatment needs (59).

Table 8: Significant correlations between temporomandibular disorders (TMD) diagnoses and self-reported variables.						
Self-reported variables	Yawning	Smiling/laughing	Chewing	Cleaning teeth/face	Exercising	Talking
Myofascial pain	✓	✓	✓	✓		
Arthralgia	✓			✓	✓	
DDwR						✓
TMD total	✓	✓				
✓ Significant association; DDwR = Disc Displacement with Reduction						

Research has shown that myogenic pain is more intense and more correlated with distress than joint-related pain in adults (117). Study III found that almost all of the myofascial pain group reported pain occurring once a week or more, whereas only two-thirds of the arthralgia group reported pain at this frequency. Furthermore, children and adolescents with myofascial pain reported higher GCPS scores than children and adolescents with arthralgia. Taken together, although children and adolescents with TMD diagnoses scored higher on the GCPS than children and adolescents in the No TMD group, the number of children and adolescents in the TMD group who didn't seek any kind of treatment for their pain was relatively high. This warrants further investigation.

The finding contrasts with findings from another study in adults that showed that the probability for someone to seek TMD treatment is directly associated with their pain severity and frequency (166). An explanation for this difference might be that children are less capable of expressing the exact nature of OFP and jaw dysfunctions, as suggested by Howard *et al.* (2013) (60). Another reason might be that some children were incapable of reporting their pain accurately away from their parents, as a previous study found that girls reported pain more accurately in their mother's presence (167).

Psychosocial and somatic perspectives

Table 9: Significant values of psychosocial factors obtained from the Youth Self Report.

	Pain-free TMD	TMD-pain
Anxious/Depressed	---	√
Withdrawn/Depressed	---	√
Somatic Complaints	---	√
Social Problems	---	√
Thought Problems	---	√
Aggressive Behavior	---	√
Affective Problems	---	√
Anxiety Problems	---	√
√ significant association, $p < 0.05$		

As Table 9 shows, children and adolescents with TMD-pain have stronger associations with the characteristics "Anxious/ Depressed" and "Withdrawn/ Depressed" than children and adolescents with no pain from their TMD. These results agreed with many studies performed among children and adolescents (65, 78).

Hongxing *et al.* (2015) showed that adolescents in a TMD-pain group reported “not feeling well” and also presented with poor self-perceived oral health (71). Further, it has been shown that dissatisfaction with life in adolescents is a strong predictor of initial clinical TMD-pain (89). Another longitudinal study demonstrated a continuation of anxiety and emotional conditions from childhood into adulthood that met the criteria of the DSM-VI (168).

The notion of a higher level of psychosocial problems now than before, especially in children and adolescents as one study done in the US reported (169), and the associations of psychosocial problems with somatization might explain the higher prevalence in Saudi Arabia, including OFP. Taken together, a dentist with knowledge of OFP/TMD could help prevent these psychosocial problems from continuing into adulthood, by early discovery of these problems when a child presents signs of OFP and/or TMD at a visit to a dental clinic.

Similar to Study IV, a population-based study revealed that OFP could lead not only to psychological problems, but also to widespread bodily pain (somatization) (170). This is important as previous reports indicate an association between somatization and depression among adolescents who have suffered from TMD-pain previously. However, one study showed that somatic complaints and distress in life were not only associated with the risk of facial pain in adolescence but were also positively correlated with the risk of OFP as defined by the RDC/TMD (89).

Moreover, Study IV found aggressive behavior to be significantly correlated with TMD-pain compared to the No TMD group. This finding is similar to two previous Swedish studies which reported that aggressive behavior and nervousness were present in adolescents with TMD-pain (78, 171). Further, one longitudinal study reported that aggressive behavior in childhood persists until adulthood (168). With this in mind, one could argue that this demands clinical consideration from dentists as well.

Our study shows the median score for physical activities among both boys and girls to be at borderline clinical levels, with boys’ scores equal to girls’ scores in all groups including the No TMD group. Many studies that have reported that physical activities are limited in children and adolescents with pain, not only for TMD-pain but also pain in other parts of the body (94). As stated earlier, this finding might contribute in the explanation of sex differences between the groups in Study IV.

Figure 9 presents the frequencies of somatic complaints and their significant associations with TMD-pain compared to the No TMD group and the Pain-free TMD group. Similar to the current findings, earlier studies have shown associations between TMD and headache in children and adolescents (159). An 8-year longitudinal study reported that TMD is significantly correlated with a number of psychosomatic disorders in adolescents and young adults: dizziness, irritability, anxiety, loss of energy and tiredness, stomachache, headache, and sleep disturbances (172).

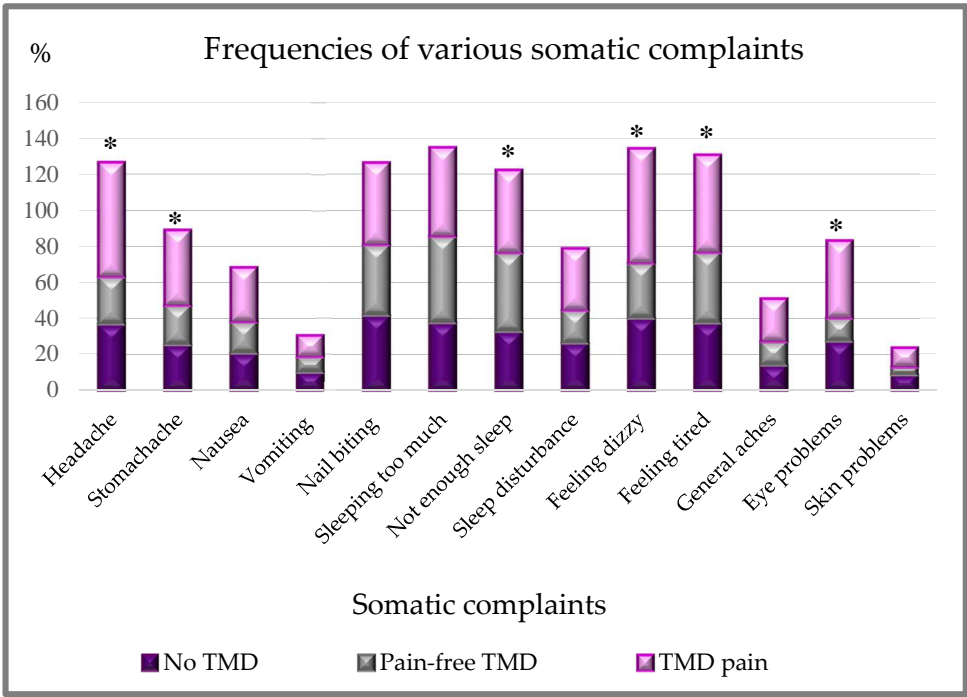


Figure 9: Somatic complaints reported by 456 children and adolescents on the Youth Self Report questionnaire.
 * Significant association with TMD-pain for each complaint.

Remarkably, abdominal pain was the most frequent type of pain that co-occurred with headache and TMD in children and adolescents (61, 72). These findings are similar to the findings of Study IV, illustrated in Figure 9. Another study concluded that physicians who treat children with headache should consider TMD as differential diagnoses, especially when children present with earaches, fatigue, and jaw stiffness. This indicates an increased pain tendency for children with TMD (173).

PROFESSIONAL KNOWLEDGE AND SKILLS

Table 10: The number of responses in the specialist groups that differed significantly from the reference group responses (in parentheses) in Sweden and Saudi Arabia.

	Sweden				Saudi Arabia				
Domains	GD	OMS	OP	PP	GD	OMS	OP	PP	GP
Chronic pain and pain behavior	1 (4)	1 (4)	1(4)	0 (4)	2 (4)	2 (4)	3 (4)	2 (4)	1 (4)
Etiology	4 (8)	4 (8)	5 (8)	4 (8)	5 (8)	5 (8)	5 (8)	6 (8)	6 (8)
Diagnosis and classification	3 (7)	0 (7)	1 (7)	2 (7)	2 (7)	4 (7)	4 (7)	3 (7)	4 (7)
Treatment and prognosis	5 (10)	3 (10)	7 (10)	6 (10)	8 (10)	6 (10)	8 (10)	6 (10)	8 (10)
GD = General dentists; OMS = Oral and maxillofacial surgeons; OP = Orthodontists and pediatric dentists; PP = Pediatric physicians; GP = General medical practitioners									

Chronic pain and pain behavior

There was a high level of agreement in the professional knowledge of all participants from both Sweden and Saudi Arabia (with higher agreement in the Swedish groups) compared to the reference group, Table 10. This finding is in contrast with other studies reporting a lack of knowledge regarding the pathophysiological aspect of pain among healthcare practitioners (174). Unexpectedly, the self-assessment of knowledge regarding this domain was only significant in the Swedish groups ($p = 0.01$) and not in the Saudi Arabian groups, Table 11. This indicates that most participants were unaware of having actual knowledge in this domain. This can be explained by the notion that tacit knowledge is difficult to recognize and/or express by traditional methods such as oral or written. Tacit knowledge can, instead, be transferred through interaction with others – “socialization” – and by reflection on one’s own experiences – “externalization” – as shown in the knowledge conversion cycle (Figure 1). These processes help practitioners recognize and transfer their own tacit knowledge (24).

Etiology

Table 10 shows poor professional knowledge concerning etiology among all participants in both countries. This finding agrees with a previous study that found that, although 60% of otalgia cases were due to OFP in children, physicians would treat patients' headache and earache without considering TMJ problems (173). Moreover, Swedish dentists showed a significant association between self-assessed knowledge and actual knowledge ($p < 0.01$) while Saudi Arabian dentists did not, that is, they overestimated their knowledge (Table 11). Dunning and Kruger (2009) concluded that less knowledgeable individuals overestimated their own knowledge more than highly knowledgeable individuals (30). Another study reported unprofessional behaviors among 40% of the Saudi Arabian undergraduate and graduate dental students. However, the same study suggested the importance of enhancing teaching quality in order to improve students' professional behavior (175).

Diagnosis and classification

The Swedish group showed less difference in professional knowledge compared to the reference group than the Saudi Arabian group, whereas all groups from both countries showed significant associations ($p < 0.05$) between their actual knowledge and self-assessed knowledge (Tables 10 and 11). Tegelberg *et al.* (2007) reported that general dentists differ most in this domain, especially older dentists, compared to OFP specialists, which contrasts with our findings (151). One reason for this difference could be the attention paid in the OFP curriculum in Swedish schools to the evolution of the RDC/TMD into the new DC/TMD, which might increase knowledge among younger practitioners.

On the other hand, the lower level of knowledge among Saudi Arabian practitioners in this domain might be because education on OFP/TMD in Saudi Arabia is traditionally theoretical, depending on lectures and formal examinations. Clinical training is not usual in OFP/TMD teaching in Saudi Arabia, nor is clinically-oriented regulatory learning, such as self-assessment, reflection, and self-observation (28, 176). Quirk (2006) discussed the differences between traditional learning and regulatory learning. He suggested that traditional learning promotes only cognitive learning and that it should thus be paired with clinically-oriented regulatory learning in order to support metacognitive learning in medical education (28). Another reason for the lower level of knowledge among Saudi Arabian practitioners might be the lack of OFP/TMD specialists in Saudi Arabia. Research indicates that a qualified practitioner should manage OFP (177).

Treatment and prognosis

All participants in both countries reported limited professional knowledge of treatment and prognosis (Table 10) with the Swedish practitioners showing slightly more professional knowledge than the Saudi Arabian group. Table 11 shows significant associations between actual and self-assessed knowledge in this domain among the Swedish group only ($p < 0.01$). One study reported that more than 80% of OFP/TMD cases were successfully treated by Swedish general dental practitioners. This report might reflect the quality of Swedish undergraduate education in OFP/TMD (105).

Table 11: The number of self-report responses in the specialist groups that were significantly associated with reference group responses (in parentheses) in Sweden and Saudi Arabia.		
Domains	Sweden	Saudi Arabia
Chronic pain and pain behavior	1 (4)	0 (4)
Etiology	3 (4)	0 (4)
Diagnosis and classification	4 (4)	3 (4)
Treatment and prognosis	4 (4)	0 (4)

A recent German study showed limited knowledge of TMD treatment among dentists who had graduated within the last 10 years compared with dentists who had graduated more than 10 years ago (178). This finding might be one explanation of the limitations in the knowledge of Swedish practitioners as their median years of experience were 10 or fewer.

On the other hand, a study done in Saudi Arabia examined possible factors that might influence undergraduate and graduate dental students' achievements and in turn their performance. That study presented suggestions to improve the lack of knowledge among postgraduate dental students based on modifying dental education by increasing positive feedback and self-assessment to enhance students' skills, knowledge, and performance (179). Thus, findings were similar to the findings in Studies I & II.

GENERAL DISCUSSION

Studying a condition's prevalence and features in the population will help identify the population at risk and bridge the gaps between its diagnosis, treatment needs, and proper management.

The main finding of this thesis is that TMD prevalence among the general population of children and adolescents in Saudi Arabia is 27.2%, which is similar to the prevalence of TMD signs and symptoms reported in previous studies of Saudi Arabian children, adolescents, and young adults. Farsi (2003) and Feteih (2006) reported a prevalence of TMD signs and symptoms among children and adolescents in Saudi Arabia between 20% and 33% ([62](#), [64](#)). Abdel-Hakim (1996) reported a prevalence of TMD-pain among adolescents and young adults of about 35.7% ([180](#)), while a recent study found self-reported TMD signs and symptoms among about half of Saudi young adults ([181](#)).

In contrast, studies from other countries that used the same methodology have reported lower prevalences of TMD. Wu and Hirsch (2010) reported the prevalence of TMD diagnoses among adolescents to be 13% in Germany and 14.9% in China ([68](#)). In Mexico, however, Casanova-Rosado reported a higher prevalence of TMD diagnoses in adolescents and young adults of about 46%. Another recent study reported a TMD-pain prevalence of 5.1% among Swedish adolescents compared to 14.8% in an age-matched Chinese adolescent population ([71](#)).

A recent meta-analysis review concluded that the rate of clinical signs of TMD in children and adolescents is 16%. However, the same review recommended using the RDC/TMD examination in children and adolescents to standardize results from different countries ([182](#)). This finding might explain the differences in prevalence between countries. Similar to the present findings, other studies in Saudi Arabia have reported high pain prevalences in children for conditions such as headache, stomachache and chest pain ([183](#), [184](#)). Further, the high prevalence of TMD according to the RDC/TMD (Axis I and II) in Saudi Arabia was also shown in a study on adult patients. That study not only found high TMD prevalence (18%) but also high frequencies of depression and somatization ([185](#)).

Also similar to other studies, this thesis found that children and adolescents with TMD-pain also reported emotional problems, somatic complaints, and less sleep ([78](#)). It is known that the memory of unpleasant and/or pleasant emotions play a role in pain experience in children and adolescents. This shows when adolescents who have experienced TMD-pain accompanied by emotional problems are frequently complain about recurrent pain in other body parts when their emotional system is stimulated ([90](#)). Thus, it has been suggested that pain in might share a common neurobiological pathway with emotions and sleep. A contemporary study suggested that the

neurotransmitters influencing pain sensitivity (e.g., serotonin and noradrenaline) are also involved in sleep and emotions (186). In brief, serotonin is a transmitter in the descending inhibitory pathways, so that lowered levels of serotonin could be responsible for painful symptoms in depressive and/or anxious patients (87). Additionally, the lowered action of noradrenaline might play a role in the development of painful symptoms and depression, in turn, affect sleep patterns (187). Until now, this mechanism is poorly understood.

This combination of emotional problems, somatic complaints, and less sleep with TMD-pain could arise from a sensitization of the central nervous system, that is, pain hypersensitivity, which has been shown to be a common pathway for many functional pain disorders (188). The activation of muscles and/or the TMJ stimulates the nociceptors at the site that, in turn, stimulate neurons in the caudal subnuclei of the trigeminal brainstem sensory nuclear complex. This stimulation will cause neoplastic changes in these neurons that amplify nociceptive signaling and increase responses to noxious stimuli. This central sensitization process alters pain sensitivity and causes referral of pain to other body parts. Depression and stress may lower the pain threshold and contribute to the central sensitization process (189).

One other potential cause of the high incidence of TMD is the level of professional knowledge among healthcare practitioners who work with children and adolescents on a daily basis. Previous studies suggest that a lack of knowledge among practitioners concerning pain in children and adolescents may explain its high prevalence (108, 190). One recent study found that the increased incidence of post-operative pain in children was due to a failure among nurses to apply their knowledge (191). Another study referred to the problem of a lack of specific education with regard to pain/OFP subjects (192). Other studies have suggested that researchers develop a different definition for TMD than the RDC/TMD (2, 65). The outcomes of Studies I & II show a lack of knowledge among dental and medical practitioners working in Sweden and Saudi Arabia, though the Swedish practitioners showed more accurate knowledge than their Saudi Arabian counterparts. The studies also showed that Swedish dentists more accurately assessed their own knowledge of OFP/TMD.

In recent years, due to the massive growth of knowledge in this field, interest in OFP education has increased. Many studies have highlighted the need for proper OFP education at both the undergraduate and postgraduate levels in dental schools (193, 194). Nevertheless, it remains crucial not only to include adequate coverage of OFP in the dental curriculum, but to establish effective clinical training programs that employ recent developments in educational methods. Further, the emphasis in medical/dental education strives to ensure that graduates can achieve professional competence and then professionalism. Research suggests that, in addition to suitable scientific

knowledge and clinical skills, knowledge of your own limitations, the ability to collaborate, and the ability to evaluate your own knowledge are important factors that lead to professionalism (11, 12). Yet, it is important for healthcare practitioners to develop and mature their understanding of all acquired information to enhance their performance and self-awareness. This can be accomplished by monitoring, controlling, and self-regulating that knowledge to reach a state of metacognition and lifelong learning (24).

One of the issues that emerges from these findings is that Swedish practitioners relied not only on their acquired knowledge while answering the questionnaires, but also on their attained clinical skills at the metacognitive level (19, 24, 28). However, those skills seem to be less evident among Saudi Arabian practitioners included in the study. This may be for several reasons, including a lack of appropriate reflection on their own knowledge leading to a deficit in self-assessment skills (176). For those reasons, Saudi Arabian practitioners might not be able to apply metacognition to their work. This would be a potential barrier, not only for proper OFP/TMD management in Saudi Arabia, but potentially, management in other medical fields as well. However, this barrier could partly explain the high prevalence of TMD among children and adolescents in the general population in Saudi Arabia.

In this respect, Quirk (2006) showed that once practitioners reach the metacognitive state, it will continuously stimulate higher-order thinking through knowledge management, self-assessment, and conscious reflection. Thereby, performance and professionalism will improve and, eventually, practitioners' intuition will also improve, allowing them to make important clinical decisions quickly at the unconscious level. Experts usually work in this state of intuition, enhancing their ability to manage ill-defined problems (28). This sequential process of learning, combined with a conceptual model (Figure 10), should be integrated into medical education to enhance its efficacy and increase the number of future experts.

Clinical implications

TMD in children and adolescents includes not only pain, headache and individual suffering but is also associated with psychosocial factors. With this in mind one can understand why OFP/TMD examination in children and adolescent is necessary during the traditional screening examination process, especially when the patient's main complaint is pain. This would in turn, in some cases, also require referral of the patient to a specialist with knowledge about OFP/TMD management. Thus, taking the results from the present thesis into consideration, one could suggest that the Saudi Commission for Health Specialties (SCFHS) and Saudi Dental Society (SDS) would

consider to establish an additional specialty in dentistry, “orofacial pain and jaw function”. This in order to ensure the best possible care both regarding OFP/TMD but also in order to minimize the impact of OFP/TMD on the psychosocial situation.

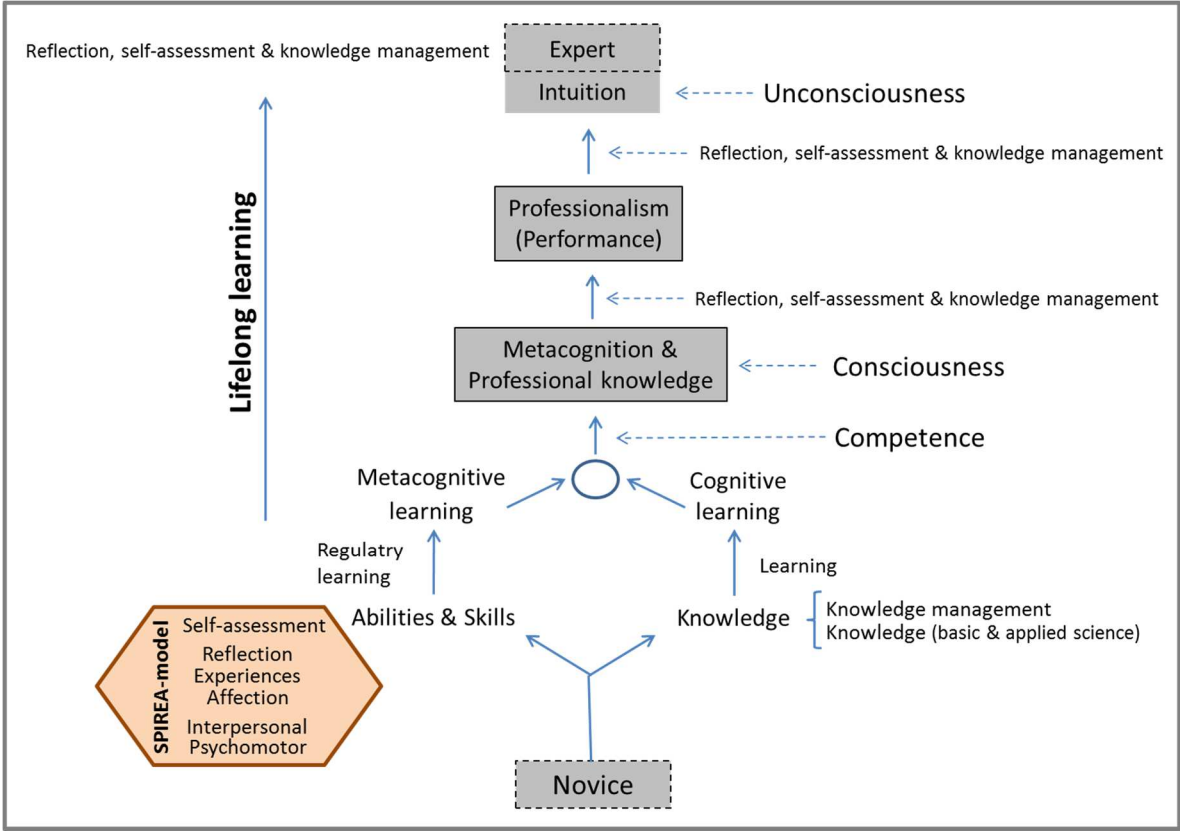


Figure 10: Conceptual model: Professional education from learner to expert.
(based on the results from the thesis)

CONCLUSIONS

Taking all four studies together, this thesis concludes that:

1. TMD in children and adolescents is more prevalent in Saudi Arabia than many other countries.
2. More than half of TMD cases were diagnosed with myofascial pain.
3. Only girls received a diagnosis of myofascial pain with limited mouth opening, which might indicate one aspect of sex differences related to TMD.
4. There were no significant differences in age or sex between any of the TMD groups.
5. The studies found TMD-pain to be correlated with depression, anxiety, aggressive behavior, and somatic complaints; headache, stomachache, eye problems, and feeling tired and dizzy.
6. The social relationships reported by children and adolescents were normal, despite the presence of TMD-pain.
7. Compared with the reference (OFP) group, Swedish healthcare practitioners showed slightly more professional knowledge than Saudi Arabian practitioners. However, this difference was not significant in all domains.
8. The use of modern medical education techniques seems to have a lifelong positive impact on professional knowledge.

RECOMMENDATIONS FOR FUTURE RESEARCH

OFP/TMD is a collective title for a variety of issues. Thus, future research should seek deeper knowledge and understanding in this area, particularly in children. My suggestions for future research are to:

1. Validate the DC/TMD in children.
2. Apply the DC/TMD in studies of children.
3. Measure the frequency of untreated OFP cases in children and adolescents in Saudi Arabia and determine possible causes.
4. Evaluate modern educational methods in Saudi Arabia.
5. Study the effectiveness of the OFP/TMD curriculum in Swedish dental schools.
6. Re-evaluate professional knowledge among Swedish healthcare practitioners

STRENGTHS AND LIMITATIONS OF THE THESIS

Studies I & II

The questionnaire used in these studies was valid and feasible for use. As LeResche *et al.* (1993) showed, it was created by many specialists in the field and its widespread use allows for comparison of many studies. One strength of these studies was their comparison of the target groups with OFP specialists, as well as the level of consensus between the OFP specialists. Additionally, the pilot sample provided a considerable amount of feedback from participants who were not included in the main studies.

Using a convenience sample of medical and dental practitioners could be considered a limitation. It created difficulties in obtaining the required information about the practitioners in both countries. Furthermore, in Saudi Arabia it was difficult to send and receive the questionnaires by regular mail, as was done in Sweden, for many reasons, including that not all participants had a mailing address. Therefore, the best method of contact for these studies was to deliver and receive the questionnaires by hand.

Another possible limitation of these studies is that the cover letter contained statements about JIA that might have impacted the participants' understanding of the aims of the study. One might consider the low response rate in Sweden (53.2%) as a limitation, but at present, it is a common response rate due to the rising number of questionnaire studies being conducted and the lack of time to complete them (195, 196). The response rate, however, is close to the general mean response rate of 61% (197). Another reason for the Swedish participants might be that the questionnaire was in English.

Studies III & IV

The randomization of children and adolescents from five regions in Jeddah city was a strength of the study as it allowed the results to be generalizable to the Saudi Arabian population. Furthermore, the use of the RDC/TMD method, which is both reliable and standardized not only for adults but also for children and adolescents, was a strength of the studies because it allows for comparison with past and future studies using the same method.

The fact that these studies employed only one examiner, trained by an OFP/TMD specialist and calibrated with a gold-standard expert in the field was another strength. The same examiner examined all children, which removes the potential for error introduced by having multiple examiners. Finally, the use of self-reported methods,

such as the YSR and RDC/TMD questionnaires, was a strength since many researchers considered them to be the gold-standard method.

The unequal number of children and adolescents between the two samples might be considered a limitation. Furthermore, the use of internet-based randomization for the schools might also limit the study when compared with using a stratified sample method that might provide more stratification within each region and a more normally distributed sample. Finally, participation of multiple nationalities in Studies III & IV might be considered a limitation; however, more than 90% of the examined children and adolescents were born in Saudi Arabia. The historical background of Jeddah might explain the multiple nationalities. Jeddah lies near the two holy Muslim cities of Mecca and Medina, and this location provides a multicultural foundation for the population. With this in mind, one could speculate whether the results of these studies are specific for Saudi Arabia or if they can be generalized to include the Middle East region.

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